ABSTRACTS OF NORTH AMERICAN GEOLOGY

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INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

The numbers assigned to the abstracts in this publication are for reference in using the index; they are not order numbers. Publications cited here in abstract form are available in most geological libraries or through interlibrary loan.

Abstracts of North American Geology and the Bibliography are prepared by use of computer techniques. Each abstract, along with its indexing, is placed on magnetic tape and entered into a permanent data bank. The material prepared each month is published in the form of the present issue. The abstracts are arranged alphabetically according to senior author. A subject index follows the abstracts and is designed for rapid reference to any subject desired. Bibliographies can subsequently be retrieved according to the terms used in the index.

A list of journals commonly cited in Abstracts of North American Geology may be obtained by writing to the U.S. Geological Survey, Washington, D.C. 20242. Serial publications cited for the first time are as follows:

Assoc. Am. Geographers Comm. College Geography Resource Paper—Association of American Geographers, Commission on College Geography Resource Paper. Washington, D.C.

Rev. Española Micropaleontología—Revista Española de Micropaleontología. Nacional "Adaro" de Investigaciones Mineras S.A. Madrid, Spain.

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

ABSTRACTS

04124 **Abbott, Agatin T.; Pottratz, Steven W.** Marine pothole erosion, Oahu, Hawaii: Pacific Sci., v. 23, no. 3, p. 276-290, illus., tables, 1969.

Along certain sections of the shorelines of Oahu, erosion is being hastened by wave-induced pothole drilling. Most potholes occur in the active wave-surge zone and are drilled in basalt, volcanic tuff, and calcareous beachrock. Rock type is an important factor in controlling the diameter-depth ratio. In basalt the average is 1.1, in volcanic tuff it is 1.6, and in beachrock 2.1. —Authors' summary

Abdel-Gawad, Monem. *See* Blander, Milton. 03966

Abel, John F., Jr. *See* Lee, Fitzhugh T. 03757

03765 **Adams, John W.** Distribution of lanthanides in minerals, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C38-C44, illus., 1969.

Fractionation of the lanthanide group of elements by natural processes is well demonstrated in rare-earth-bearing minerals, where variation in the relative abundance of these elements is found not only between individual species, but also in the same species in different deposits. Several mechanisms, such as ionic-radii differences, basicity, and accomodation in crystal lattices, may contribute to fractionation.—Author's abstract

04331 **Adams, Samuel S.** Bromine in the Salado Formation, Carlsbad potash district, New Mexico: New Mexico Bur. Mines and Mineral Resources Bull. 93, 122 p., illus., tables, 1969.

From investigations in drill cores and underground workings, bromine content of halite ranges from 25-105 ppm, which, in the presence of sylvite, suggests that much of the Salado Formation is second cycle. Changes in bromine content of halite across stratigraphic boundaries correlate with changes in mineralogy and lithology, indicating these features formed during deposition, and bromine content of halite has not changed substantially since deposition. Bromine contents of halite and sylvite in the first ore zone suggest initial precipitation of a halite-sylvite assemblage was succeeded by precipitation of halite-carnallite; carnallite replaced some sylvite but was later converted to sylvite during early diagenesis. Bromine content of halite aids in identifying salt horses in drill cores; its distributions are of value in regional exploration. —*from* Author's abstract

04159 **Agterberg, F. P.; Banerjee, I.** Stochastic model for the deposition of varves in glacial Lake Barlow-Ojibway, Ontario, Canada: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 625-652, illus., tables, 1969.

Both sedimentological evidence and the results of statistical analysis support Kuenen's model for varve deposition by turbidity currents. Proximally, individual varves merge with the crossbedded deltaic sands and gravel of eskers. Distally, they change successively from sandy to silty, and then to diamictic facies. Both the silt (summer) and the clay (winter) layers in a varve couplet show an approximately exponential decrease in thickness away from the ice front. The genetic difference between the silt (from turbidity current deposition) and the clay (deposited from suspension) is reflected in the statistical behavior of their thickness-time series. Silt and clay residual thickness data satisfy a Markov model of the second order after

elimination of noise and thinning effects. Two weakly-developed short term cycles have also been detected. —*from* Authors' abstract

Agyei, E. K. *See* Schwarcz, H. P. 03838

Aizawa, Hiroko. *See* Kigoshi, Kunihiko. 03941

04332 **Albert, C. D.** Total sediment discharge of selected streams in Kansas, 1957-65, a compilation: Kansas Water Resources Board Bull. 10, 8 p., illus., table, 1969.

The presented information, not included in published annual reports, is useful in planning for utilization and development of water resources. The suspended load of streams is computed from analyses of depth integrated samples, down to within 0.3 ft of the stream bottom. In a sandbed stream the sediment concentration is normally higher and particle size larger in the unsampled than in the sampled zone. Thus the total sediment discharge of many streams may be appreciably greater than indicated by samples alone. A modified Einstein procedure applies where the stream cross section has uniform lateral distribution of depth, velocity flow, and sediment concentration. Shifting and irregular thalwegs of Kansas streams, with nonuniform flow parameters, require multiple computations. Tables include total and suspended-sediment discharge. —GDC

04318 **Alexander, W. H., Jr.; Patman, J. H.** Ground-water resources of Kimble County, Texas: Texas Water Devel. Board Rept. 95, 93 p., illus., tables, 1969.

The aquifer formed by the Edwards and associated limestones is the most extensive source of fresh ground-water; in addition to flow of springs, it supplies water for rural uses, an estimated 420 acre-feet in 1964. Theoretical amount available is about 33,000 acre-feet per yr. Alluvial deposits along major streams supply more than half the well supply; although relatively small in area and in capacity to store water, total quantity for future development is closely related to Llano River minimum base flow at the Junction gaging station. Relatively shallow wells in valleys and tributaries of rivers supply water for rural and limited irrigation uses from sands and sandstones in the Hensell Member of the Pearsall Formation; most water is fresh in the eastern part but slightly saline in the western. —*from* Authors' abstract

03925 **Allaud, L. A.; Ringot, J.** The High Resolution Dipmeter tool: Log Analyst, v. 10, no. 3, p. 3-11, illus., 1969.

A new dipmeter tool, designed to obtain a very high vertical resolution at reasonably fast logging speeds, incorporates a new microresistivity sensor capable of a resolution of 0.2 inches, and an entirely new telemetry system that can handle the data acquired at a 3,600 ft-per-hour speed. Digitally recorded on magnetic tape, it is at the same time optically monitored with galvanometers and film. Hydraulically powered, its four-arm electrode assembly improves pad application in boreholes that are deviated, irregular, or caved. To eliminate errors in dip computations, continuously measured downhole sonde velocity is incorporated. The programs used for machine computing the taped dipmeter data afford flexibility. Results can be positioned accurately with respect to conventional resistivity curves.—GDC

04070 **Allen, J. R. L.** Erosional current marks of weakly cohesive mud beds: Jour. Sed. Petrology, v. 39, no. 2, p. 607-623, illus., table, 1969.

The manner in which a bed of weakly cohesive mud is eroded by a plain, turbulent flow of water is found experimentally to depend upon the severity of the flow over the bed. The major structures left behind on a weakly cohesive mud bed after a prolonged period of erosion also depend upon the severity of the flow. With ascending severity we obtain: (1) longitudinal rectilinear grooves, (2) longitudinal meandering grooves, (3) flute marks, (4) transverse erosional markings. The more severe flows also give rise to shear wrinkles and to erosional structures of a less well-defined nature. Of the four structures enumerated, all but longitudinally rectilinear grooves have counterparts in the fossil record. Of particular importance is evidence confirming that the flute marks are associated with separated flows and are due to processes of flow separation and reattachment. —Author's abstract

Altschuler, Z. S. *See* Fleischer, Michael. 03968

04284 **Am. Soc. Civil Engineers.** (Task Comm. on Preparation of Sedimentation Manual). Sediment measurement techniques—[Pt.] A, Fluvial sediment: Am. Soc. Civil Engineers Proc., v. 95, paper 6756, Jour. Hydraulics Div., no. HY 5, p. 1477-1514, illus., tables, 1969.

Modern techniques and equipment are described for engineers not familiar with sediment measurement on natural streams. Typical examples of sedimentation characteristics, such as distribution of sediment with distance above the bed, variation of concentration with time and position in the stream cross section, illustrate some of the problems of sediment measurement. Equipment available is described for obtaining suspended load concentration, bed load discharge and bed sediment samples. Planning is outlined for making measurements at a cross section to obtain the sediment discharge of a stream, and procedure is presented for making the necessary calculations based on measured data. The method of obtaining long-time records includes determination of the frequency of making measurements in order to achieve desired accuracy. —*from* ASCE abstract

04285 **Am. Soc. Civil Engineers.** (Task Comm. on Preparation of Sedimentary Manual). Sediment measurement techniques—[Pt.] F, Laboratory procedures: Am. Soc. Civil Engineers Proc., v. 95, paper 6757, Jour. Hydraulics Div., no. HY 5, p. 1515-1543, illus., tables, 1969.

Techniques and apparatus used in laboratory measurements made in connection with field sedimentation investigations are described. First discussed are expected and needed accuracy and the reliability of measurements. For determining particle size and particle-size distribution, methods described include the visual accumulation tube method and recently developed bottom withdrawal method as well as classical methods such as sieving and the pipet method. The final section deals with less common measurements, such as the determination of content of organic matter in sediment samples and dissolved solids in the water of samples. The report contains seven diagrams and a bibliography of 21 references. —*from* ASCE abstract

04289 **Am. Soc. Civil Engineers.** (Task Comm. on Saltwater Intrusion). Saltwater intrusion in the United States: Am. Soc. Civil Engineers Proc., v. 95, paper 6788, Jour. Hydraulics Div., no. HY 5, p. 1651-1669, table, 1969.

The occurrence of saline water is described in terms of geologic and hydrologic conditions. The three general mechanisms of intrusion are considered [reversal or reduction of ground-water gradients, destruction of natural barriers, and disposal of waste saline water]. The extent of salt water intrusion is given using a detailed listing of examples from throughout the United States. Statements are included regarding some of the areas where major control efforts are underway. —ASCE abstract

Anders, Edward. *See* Fuse, Kiyono. 03972

Anderson, Don L. *See* Hanks, Thomas C. 03677

03907 **Anderson, Don L.; Julian, Bruce R.** Shear velocities and elastic parameters of the mantle: Jour. Geophys. Research, v. 74, no. 12, p. 3281-3286, illus., table, 1969.

The recent shear wave traveltime data of Ibrahim and Nuttli (1967) and Doyle and Hales (1967) is reinterpreted to yield a shear-velocity structure that is compatible with Johnson's (1967) compressional-velocity structure. The elastic parameters Φ, K/μ, and σ are calculated as a function of depth. All three parameters increase with depth in the homogeneous regions of the mantle but only Φ increases through the transition regions. Poisson's ratio is apparently less for the close-packed deeper mantle phases than it is for the normal phases of the upper mantle. The theoretical prediction that $d\mu/dP$ becomes negative before a phase change is verified by the seismic data.—Authors' abstract

04055 **Anderson, Don L.** Bulk modulus-density systematics: Jour. Geophys. Research, v. 74, no. 15, p. 3857-3864, illus., tables, 1969.

The elastic constants of crystals show a general tendency to increase as the mean molar volume decreases. The role of other factors can now be discussed with available elastic constant data. For a given coordination the parameter v_e decreases with increasing cation radius and with cell volume per oxygen atom unless a nonspherical transition element ion substitutes for a nontransition ion. The calcium effect discovered by G. Simmons [1964] is a special case of cation radius effect. The elastic ratio Φ_e for complex oxides is approximately a molar average of Φ_e of component simple oxides. For silicates, an empirical table of Φ_e (SiO_2) can be constructed for various mineral groups. Tentatively, Φ_e (SiO_2) is roughly that of α quartz for the feldspars, β quartz for olivines and pyroxenes, coesite for garnets, and stishovite for spinels. —Author's abstract

04083 **Anderson, Don L.; Kovach, Robert L.** Universal dispersion tables—[Pt.] 3, Free oscillation variational parameters: Seismol. Soc. America Bull., v. 59, no. 4, p. 1667-1693, illus., tables, 1969.

The effect of a small change in any parameter of a realistic Earth model on periods of free oscillation is computed for spheroidal and torsional modes. Normalized partial derivatives, or variational parameters, are given as a function of order number and depth in the Earth. For a given mode it can be seen which parameters and regions of the Earth are controlling the period of free oscillation. Except for $_0S_2$ and its overtones, low-order free oscillations are relatively insensitive to core properties. Mantle shear velocity is the dominant parameter controlling periods of free oscillation and density can be determined from free oscillation data only if shear velocity is known accurately. Free oscillation data can be used to modify average upper mantle density. Mass and moment of inertia are then the main constraints on how mass must be redistributed in lower mantle and core. —Authors' abstract

Anderson, J. U. *See* Pease, D. S. 04298

04102 **Anderson, M. M.; Misra, S. B.** Criteria for recognizing Pre-Cambrian fossils: Nature, v. 223, no. 5210, p. 1076, 1969.

The communication (ibid., v. 220, no. 5168, p. 680-681, 1968) discussed by Golding (ibid., same page) did not describe the new Precambrian fossils from Newfoundland but merely gave brief details of a metazoan fauna in order to announce this important discovery; it was indicated quite clearly that details would be published elsewhere. Reasons for considering them to be organic were: they are restricted to certain bedding planes; they lie on ripple-marked surfaces; their orientation is unrelated to ripple marks or cleavage or other fracture patterns, and some commonly straight forms are also found curved; they are unrelated to sedimentary structures; their forms are varied; there is a (possibly ontogenetic) variation in size; some forms are complex; and they are similar to known Precambrian fossils. Any resemblance to cone-in-cone structure is illusory. —DBV

04038 **Anderson, Thomas F.** Self-diffusion of carbon and oxygen in calcite by isotope exchange with carbon dioxide: Jour. Geophys. Research, v. 74, no. 15, p. 3918-3932, illus., tables, 1969.

Carbon self-diffusion coefficients were determined by exchange between calcite grains and a large reservoir of C-14-labeled CO_2 at 250°C. Both carbon and oxygen self-diffusion coefficients were determined by exchange between calcite grains and a limited reservoir of C-13 and O-18-enriched CO_2 at 650°-850°C. Carbon diffusivity determined by both methods in unannealed and annealed material at temperatures above 550°C are given by $D = 1.3 \times 10^3 \exp(-88{,}000/RT)$ sq cm per sec, and carbon diffusivity by the C-14 method in unannealed calcite below 550°C by $D = 4.6 \times 10^{-16} \exp(-17{,}000/RT)$ sq cm per sec. Data suggest that carbon self-diffusion is depth-dependent and that solid-state diffusion will not significantly alter isotopic record of calcite. —*from* Author's abstract

Andresen, Marvin J. *See* Péwé, Troy L. 03666

Andress, B. O. *See* Disney, R. W. 04302

Angino, Ernest E. *See* Dingman, Robert J. 03800

04147 **Appleyard, Edward C.** Nepheline gneisses of the Wolfe Belt, Lyndoch Township, Ontario—[Pt.] 2, Textures and mineral paragenesis: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 689-717, illus., 1969.

The alkaline character of the nepheline-bearing gneisses has been confirmed as synorogenic in origin, apparently forming under upper amphibolite-facies metamorphic conditions during a static interval prior to the second of three periods of folding. The original 'replacement' textures were largely erased by a penetrative recrystallization during the second phase of folding. The Wolfe gneisses reflect in their paragenesis and textures this event. The problem of regional scapolitization is briefly considered. Petrographic and geologic evidence suggests the scapolite developed prior to or early in the third phase of folding. A synthesis of events in the Grenville orogeny as indicated by these rocks is attempted. —*from* Author's abstract

03960 **Archer, A. A.** The classification and specification of sands and gravels: Geol. Soc. London Proc., no. 1651, p. 217-221, 1969.

It would be mutually beneficial were geologists and soil mechanics engineers to use the same classification of sediments. Most British geologists use the Udden scale and Wentworth terms (except that, as in the U.S.A., the term 'granule' has not been generally accepted), while specialists use Krumbein's phi scale derived from them, to describe grain sizes. Diverse descriptive terms and specifications applied by engineers to sand and gravel materials for soil mechanics, concrete, and roads are reviewed. If critical size limits remain as described in 1945 (Glossop and Skempton), the Wentworth scale would give a closer fit to the adopted boundary between cohesive and noncohesive soils. A geometrical scale would ensure equal intervals on abscissa of a semilogarithmic chart; metrication could rationalize aggregate specifications. —GDC

Arkani-Hamed, Jafar. *See* Toksoz, M. Nafi. 03832

03777 **Armstrong, Richard Lee.** Correction [to "A model for the evolution of strontium and lead isotopes in a dynamic earth", 1968]: Rev. Geophysics, v. 7, no. 3, p. 665, 1969.

Two numerical corrections do not affect the conclusions or interpretations of the 1968 paper (ibid., v. 6, no. 2, p. 175-199; Abstracts of North American Geology, September 1968). The table of abundances of K, Rb, Sr, U, and Th in the Earth, which differs slightly from values recently described by P. M. Hurley, does not represent a fundamental disagreement, but is a consequence of different models of Earth history and isotope evolution processes adopted in the respective papers. Both agree on substantial depletion of the alkalis Rb and K in the Earth when compared with chondritic meteorites.—MCM

04262 **Arnold, James R.; Suess, Hans E.** Cosmochemistry, *in* Annual review of physical chemistry, V. 20: Palo Alto, Calif., Annual Reviews, Inc., p. 293-314, illus., tables, 1969.

The facts of cosmochemistry are divided into: meteorites, including trace-element and isotopic composition, and cosmic-ray bombardment effects; meteors and comets; planets and satellites; and sun and stars. The concepts are divided into: age of elements; relative abundances of nuclear species; origin of elements; and chemical fractionation processes, including atmophile elements and the cosmochemistry of rare gases, lithophile elements and their state of oxidation, chalcophile and deficient elements, and siderophile elements and abundance of iron. —ESL

04087 **Arnold, R. G.; Ferris, C. S.** Compositions of pyrrhotite and sphalerite from the Coronation mine, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 201-211, illus., tables, 1969.

Random collections of pyrrhotite and sphalerite from all levels of the mine were made with the intention of using them to provide information on the thermal listing of the ores. Recent work has shown that neither mineral is suitable for geothermometry. However, the data accumulated have been interpreted and provide useful

basic information on geological environment of formation of natural pyrrhotite. —*from* Authors' abstract

04088 **Arnold, R. G.; Rutherford, M. J.** Data for brine and carbon dioxide filled liquid inclusions in quartz veins from the Coronation mine, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 213-228, illus., tables, 1969.

Liquid inclusions occur in quartz veins cutting the orebodies in Coronation mine. Hand specimens collected from seven levels were examined and the contained liquid inclusions were found to be of three general types—brine-gas, brine-CO_2 fluid-gas, and CO_2 fluid-gas. Interpretation of the observations permitted approximate estimates of the composition of the inclusion fluids and the conditions of trapping of the fluids, assuming the inclusions to be primary. Sphalerites and silicate gangue in the orebody were also examined for liquid inclusions, but without significant results. —Authors' abstract

Axley, J. H. *See* Woolson, E. A. 04320

Bachinski, D. J. *See* Davies, J. L. 03664

03720 **Bachman, George O.; Myers, Donald A.** Geology of the Bear Peak area, Dona Ana County, New Mexico: U.S. Geol. Survey Bull. 1271-C, p. C1-C46, illus., table, geol. map, 1969.

The south end of the San Andres Mountains includes structural elements of both the westward dipping San Andres Mountains and the Organ Mountains igneous mass. Paleozoic rocks that range in age from Late Cambrian to Early Permian are about 7,000 feet thick and are well exposed. A system of high angle reverse faults, representing movement toward the north, is present in the southern part of the San Andres Mountains.—GOB

04288 **Baer, A. J.** The Precambrian geology of Fond-du-Lac map-area (74-O), Saskatchewan: Canada Geol. Survey Paper 68-61, 17 p., illus., geol. map, 1969.

South of Lake Athabasca the area is underlain by flat-lying sediments of the Athabasca Formation; granitic rocks and gneisses occupy the area to the north. One group of gneisses forms a broad belt closer to Lake Athabasca, is in granulite facies, or has undergone retrograde metamorphism from granulite to amphibolite facies; the other group, associated with granodiorite and migmatite and in the amphibolite facies, covers most of the area north of the first. The first group represents supracrustal rocks raised to granulite facies, deformed by an easterly trending gentle folding. A second period of metamorphism caused retrograde metamorphism of granulites accompanied by formation of northeasterly-trending foliation. Faulting and mylonitization are probably related to last stages of granite and granodiorite emplacement. —*from* Author's abstract

03698 **Ball, M. M.; Harrison, C. G. A.; Supko, P. R.** Atlantic opening and the origin of the Caribbean: Nature, v. 223, no. 5202, p. 167-168, illus., 1969.

A modification of Funnel and Smith's (1968) model of the opening of the Atlantic is dictated by consideration of the continuation and configuration of the Mid-Atlantic Ridge across the transverse zone of shear and extension related to the generation of the Caribbean. Continental blocks may indeed rotate about different axes, but the process by which this rotation is achieved involves changing direction and rate of oceanic crustal spreading across strike-slip faults separating thin strips of the oceanic plate. This modification makes necessary a reinterpretation of Sykes' conclusion (1967) in his discussion of Wilson's transform faults (1965).—DBV

03851 **Balsiger, H.; Geiss, J.; Lipschutz, M. E.** Vanadium isotopic composition in meteoritic and terrestrial matter: Earth and Planetary Sci. Letters, v. 6, no. 2, p. 117-122, tables, 1969.

The V-50/V-51 abundance ratios were measured in five chondrites of different selected subclasses, terrestrial diabase standard W-1, and reagent vanadium. For all of these samples the ratios agree within the limits of error. Because of the low cosmic abundance of V-50, this result places severe limits on possible differences in the irradiation histories of terrestrial and meteoritic matter. After correction for mass discrimination an average of V-50/V-51 $(2.425 \pm 0.030)X10^{-3}$ is obtained.—Authors' abstract

Banerjee, I. *See* Agterberg, F. P. 04159

04050 **Banerjee, Subir K.** Origin of weak ferromagnetism and remanence in natural cassiterite crystals: Jour. Geophys. Research, v. 74, no. 15, p. 3789-3795, illus., 1969.

The weak ferromagnetism of cassiterite (SnO_2) can be attributed to its 1 percent Fe impurity content. Saturation magnetization measurements on large single crystals as a function of temperature show superparamagnetic Fe_2O_3 or $Fe_{2-x}Sn_xO_3$ impurities to be responsible for the weak ferromagnetism. Thermomagnetic curves confirm this interpretation. Contrary to results of previous workers, no correlation was found between magnetism and the ferrous-to-ferric iron ratio, and the observed variability of Curie points is attributed to a range of blocking temperatures. More importantly, it is suggested that the NRM in cassiterite may be CRM, and hence these crystals are liable to yield incorrect paleointensity values of the geomagnetic field. —*from* Author's abstract

Banse, Karl. *See* Pamatmat, Mario M. 03680

04226 **Baracos, Andrew.** Design of foundations on Winnipeg clays [with French abs.], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 197-208, illus., table, 1969.

Case histories are given to illustrate bearing capacity, settlement, and volume characteristics of Winnipeg clays. These clays are of glacial lake origin, highly plastic, and generally irregularly varved. I have endeavored to show by calculation the relationship between soil properties determined by tests, and the behavior of the supported structure. —Author's abstract

04268 **Barker, Fred.** Gold investigations in Precambrian clastic and pelitic rocks, southwestern Colorado and northern New Mexico: U.S. Geol. Survey Bull. 1272-F, p. F1-F22, illus., tables, 1969.

A search for fossil placer deposits of gold was made in the Precambrian Vallecito Conglomerate and conglomerates of the Uncompahgre Formation in southwestern Colorado, and in the Ortega Quartzite and Kiawa Mountain Formation in northern New Mexico. These rocks contain less than 0.1 ppm gold, and apparently were derived from a terrane of quartzite, jasper, argillite, and iron formation that contained little or no gold. In addition, carbonaceous slate and schist of the Uncompahgre Formation were sampled and analyzed for gold and 29 other metals. These rocks are predominantly low in metals. —FB

Barnes, P. *See* Robin, G. de Q. 03916

Barsch, G. R. *See* Chang, Z. P. 04009

04282 **Bayazit, Mehmetcik.** Resistance to reversing flows over movable beds: Am. Soc. Civil Engineers Proc., v. 95, paper 6649, Jour. Hydraulics Div., no. HY 4, p. 1109-1127, illus., 1969.

Configuration of a movable bed changes periodically as the velocity of the reversing flow over it varies in time. Experiments are carried out with bed materials of various densities. It is seen that the ripples generated on the bed surface are essentially similar to those of unidirectional flow, but their shapes are reversed to conform with the flow direction. The resistance of such a bed depends on grain Froude number and

grain Reynolds number. The importance of viscosity in determining the resistance is emphasized. The resistance function at the instant peak velocity is determined for the conditions of movable-bed tidal models. Ripple friction factor is found not to depend on the depth and the period of the flow in the ranges used for the experiments. Relationships determining the resistance of a movable bed for tidal model conditions are presented. —ASCE abstract

04076 **Beck, A. E.; Neophytou, J. P.** Heat flow and underground water flow in the Coronation mine area, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 229-239, illus., tables, 1969.

Measurements of underground temperatures and thermal conductivities have been made in the Coronation mine area. The heat flow value corrected for structural effects is 0.7 ± 0.2 μ cal/sq cm/sec; no topographic correction is necessary but a correction for Pleistocene deglaciation would add 0.4 μ cal/sq cm/sec to this value. The determination of tritium values of surface and underground water samples indicates that the effect of water-flows can be neglected. —Authors' abstract

Beetem, W. A. *See* Grove, D. B. 03740

Beg, M. A. *See* Clarke, W. B. 03844

Benninghoff, William S. *See* Miller, Norton G. 03812

Benninghoff, William S. *See* Farrand, William R. 03813

04237 **Benson, Paul H.** Evidence against a large scale disconformity between the Upper Cretaceous Black Creek and Peedee Formations in South Carolina: South Carolina Div. Geology Geol. Notes, v. 13, no. 2, p. 47-50, illus., 1969.

Previous studies of the Cretaceous stratigraphy in South Carolina tentatively conclude that a large scale disconformity exists between Black Creek and Peedee sediments. Evidence for this disconformity is the absence of the *Exogyra cancellata* Subzone in the outcrop area. Reevaluation of the outcrop at Burches Ferry on the Peedee River suggests an intertonguing contact and possible existence of the *Exogyra cancellata* Subzone in the subsurface. —Author's abstract

04247 **Berg, R. R.** Current geological and geophysical studies in Montana: Montana Bur. Mines and Geology Spec. Pub. 46, 15 p., 1969.

This list includes projects of the U.S. Geological Survey, the Montana Bureau of Mines and Geology, and studies by university faculty members and graduate students; it will be issued annually as a supplement to *Index of unpublished geologic studies in Montana*, which is published every five years. The 138 studies are divided into the following categories: areal geology; structural geology; stratigraphy, sedimentary petrology, and paleontology; geochemistry, mineralogy, and petrology; geochronology; geophysics; geomorphology; hydrogeology; mineral fuels; and economic geology. —MCM

04120 **Berggren, William A.** Rates of evolution in some Cenozoic planktonic foraminifera: Micropaleontology, v. 15, no. 3, p. 351-365, tables, 1969.

Morphologic and taxonomic rates of evolution within some groups of Cenozoic planktonic foraminifera have been calculated. Taxonomic rates of evolution vary from a low of 0.11 species per million years in the genus *Orbulina* to 1.44 species per million years in the Neogene globorotaliids. The rate of change in the total fauna (rate of origination minus rate of extinction) shows negative values in the late Eocene and early Oligocene and in the late Miocene to Pleistocene, reflecting, in all likelihood, two crises which the planktonic foraminifera experienced during the Cenozoic. Taxonomic frequency data are plotted against a paleotemperature curve for the middle Eocene-Pleistocene interval (Devereux, 1967). Some striking similarities are seen, and possible relationships are discussed. —Author's abstract

Bermúdez, Pedro J. *See* Seiglie, George A. 03662

Bernard, Joseph L. *See* Rittenhouse, Gordon. 03843

03798 **Berry, Frederick A. F.** Relative factors influencing membrane filtration effects in geologic environments, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 295-301, 1969.

Shales serve as semi-permeable membranes. These membrane properties result from the electrostatic properties of clays and kerogen. Kerogen may be extremely important to the membrane properties of shales but there are no data at present with which to assess its importance. The factors that probably influence the relative transport rates of dissolved species through shale membranes are assessed as to their relative importance. The probable effects of temperatures, pressure, and chemical concentrations of the aqueous solutions on the total efficiency of the shale membrane and the relative passage rates of the dissolved species also are discussed. Important parameters for a better understanding of membrane behavior that require experimental and field investigations are presented.—Author's summary

03985 **Beutner, Edward Chandler.** Structure and tectonics of the southern Lemhi Range, Idaho [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4709B, 1969.

03852 **Billings, Gale K.; Bricker, Owen P.; Mackenzie, Fred T.; Brooks, Albert L.** Temporal variation of alkaline earth element/chlorinity ratios in the Sargasso Sea: Earth and Planetary Sci. Letters, v. 6, no. 3, p. 231-236, illus., tables, 1969.

An open ocean hydrographic station located 14 miles SE of the Bermuda Islands was sampled at two week intervals through a vertical profile of 2600 meters and over the period June 1966 to March 1967. Four hundred and twenty-eight samples were analyzed for Ca, Mg, Sr, and chlorinity. Large temporal variations in element/chlorinity ratios were observed throughout the water column.—Authors' abstract

03853 **Billings, Gale K.; Hitchon, Brian; Shaw, D. R.** Geochemistry and origin of formation waters in the western Canada sedimentary basin—[Pt.] 2, Alkali metals, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 211-223, illus., tables, 1969.

The population statistics for 19 anions and cations are presented, together with weighted, mean composition. Five types of water are present in the basin, but only two are discussed in detail: (1) a membrane-concentrated formation water, and (2) a formation water formed either by a mixture of no. 1 and very small amounts of bitterns resulting from halite precipitation or by hyperfiltration. The membrane is selective and leads to a relative concentration pattern in solution of Rb > K > Na > Li. The composition, and thus the ion ratios, are set by mineral-solution reactions, particularly during early diagenesis. Modification of the composition then occurs by selective filtration, further chemical reaction, and mixing during the subsequent fluid migration resulting from hydrodynamic drive.—*from* Authors' summary

03873 **Binda, P. L.** Provenance of the Upper Cretaceous Kneehills Tuff, southern Alberta: Canadian Jour. Earth Sci., v. 6, no. 3, p. 510-513, illus., 1969.

The areal distribution of the coarse fraction of ten samples of the Kneehills Tuff indicates a southern provenance for the volcanic ashes that originated the pyroclastic deposit. The *coarse index* (arithmetic mean of the fifty largest diameters in a thin section) is a useful parameter for quick grain-size studies of indurated sediments. —Author's abstract

Binda, Pier L. *See* Srivastava, Satish K. 04105

Bischoff, J. L. *See* Manheim, F. T. 03866

Blackwelder, Blake W. *See* Pilkey, Orrin H. 04062

03966 **Blander, Milton; Abdel-Gawad, Monem.** The origin of meteorites and the constrained equilibrium condensation theory: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 701-716, illus., table, 1969.

Microscopic examination and microprobe analyses were made in individual chondrules in unequilibrated meteorites. Observations as well as published data are compared with predictions and consequences of the "constrained equilibrium" theory of Blander and Katz. The large variety of textures of chondrules is shown to be consistent with the postulate that chondrules were formed as subcooled liquid drops. The distribution and concentrations of oxidized and metallic iron in equilibrated and unequilibrated chondrites are consistent with constraints imposed by nucleation kinetics and consequent supersaturation of iron vapor during the condensation process. The different contents of volatile elements of different chondrites fits the theory. Most compositional and textural features in chondrites thus could have been formed during the condensation and accretion processes in a cooling nebula. —*from* Authors' abstract

04068 **Blatt, Harvey; Sutherland, Berry.** Intrastratal solution and non-opaque heavy minerals in shales: Jour. Sed. Petrology, v. 39, no. 2, p. 591-600, illus., tables, 1969.

Non-opaque heavy minerals have been examined from contemporaneous sandstone-shale pairs of Tertiary formations on the Texas Gulf Coastal Plain. Total weight of heavy minerals in the shale is less than in the sandstone, but the same grain sizes are present in both. Sediment in the coarse and medium silt sizes contains the same variety of minerals as the very fine sand size. In shales the variety of minor minerals is only slightly larger than in contemporaneously deposited sandstones. However, the number of species present in only trace amounts is significantly larger in shales than in sandstones; the sandstones contain much larger percentages of altered grains than do the shales. Thus, shales rather than sandstones should be examined in heavy-mineral studies. Unstable species, post-depositionally dissolved in sandy beds, may be preserved in contemporaneously deposited shales. —*from* Authors' abstract

Blow, W. H. *See* Wood, G. V. 03957

Blusson, S. L. *See* Gabrielse, H. 04205

Bohner, G. E., Jr. *See* Wershaw, R. L. 03971

04040 **Borcherdt, C. A.; Meyer, R. P.; VanSchaack, J. R.** Project Early Rise—Shot times and locations: Jour. Geophys. Research, v. 74, no. 17, p. 4442-4452, illus., tables, 1969.

Shot locations for the Project Early Rise explosions fired in Lake Superior in July 1966 were calculated from the traveltimes of water waves recorded by six hydrophone stations in Michigan and Minnesota. As a check on the stability of the calculated locations, the locations and velocities were computed by successive elimination of each of the hydrophone stations. The result, together with the size of the standard deviations of the latitude and longitude, time residuals, and the consistency of velocity, suggests that the locations are sufficiently accurate for almost any conceivable seismic application. —Authors' abstract

Boshkov, Stefan H. *See* Giovanni, Barla. 04245

04211 **Bostock, H. S.** Kluane Lake, Yukon Territory, its drainage and allied problems (115G, and 115FE): Canada Geol. Survey Paper 69-28, 19 p., illus., 1969.

Changes of level of Kluane Lake suggest that the lake has not always drained through the Kluane River as it does today but has, during the Hypsithermal, drained through the Slims River valley into the Kaskawulsh River. This drainage theory was first published by the writer in 1952 and the present paper includes data which as become available since that time. Features of change of level as well as possibilities of drainage reversal are here discussed and it remains the writer's conclusion that the drainage changes suggested in his original paper did indeed occur. —Author's abstract

03899 **Boström, Kurt; Peterson, M. N. A.; Joensuu, Olva; Fisher, David E.** Aluminum-poor ferromanganoan sediments on active oceanic ridges: Jour. Geophys. Research, v. 74, no. 12, p. 3261-3270, illus., tables, 1969.

The results of 399 new analyses and 144 analyses from the literature indicate that the carbonate-free fraction of sediments from active oceanic ridges is characterized by very low aluminum and titanium content and high iron and manganese content compared with sediments from other volcanic regions and from inactive ridges. These active ridge sediments appear to originate by volcanic processes associated with ocean-floor spreading and high heat flow. The total mass of these sediments is probably only a few percent of all deep-sea sediments.—Authors' abstract

03970 **Boström, Kurt; Fisher, David E.** Distribution of mercury in East Pacific sediments: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 743-745, illus., 1969.

Fifty-seven sediments from the East Pacific have been analyzed for Hg. All high Hg-values are found on the crest of the East Pacific Rise. Either volcanic or absorption processes could explain this distribution pattern. —Authors' abstract

Boström, Kurt. *See* Fisher, David E. 04056

04052 **Boucher, Gary; Ryall, Alan; Jones, Austin E.** Earthquakes associated with underground nuclear explosions: Jour. Geophys. Research, v. 74, no. 15, p. 3808-3820, illus., tables, 1969.

Results of a search of records of the University of Nevada seismographic station network for grossly observable effects of underground nuclear tests on regional seismicity are presented. Most of the data were obtained 100-150 km from the explosions. In all cases of explosions with magnitude $m_b > 5.0$, an increase in seismicity was observed for at least one day following the test. The decay of postshot activity and its relations to the equivalent magnitude of the explosion provide confirmation of the determinative role of the nuclear event. All earthquakes related to underground tests had magnitudes lower, by at least one magnitude unit, than those of associated blasts. Attempts to determine the extent to which underground tests influence seismicity in active areas distant from the test site have indicated that, if such effects exist, they are probably minor compared with normal variations in seismicity. —*from* Authors' abstract

04217 **Bouma, Arnold H.; Rezak, Richard.** Oil found on knolls on Gulf's continental rise: Ocean Industry, v. 4, no. 5, p. 73-77, illus., 1969.

Additional evidence that hydrocarbons exist in deep parts of the Gulf of Mexico was obtained on the *Alaminos* survey. Cores, taken on several southern Nowlin Knolls are described. Two piston cores contained tarry material at the bottom and inclusions of tar higher up. Calcareous nannofossils from a hydrocarbon layer indicate a mixing of discoasters from Eocene to Pliocene in age. These preliminary results may influence our ideas on the formation and maturation of hydrocarbons, and add another order of magnitude to world oil reserves, even though they are at present beyond our technical abilities to explore and produce. —ESL

03981 **Boutwell, Gordon Powers, Jr.** On the yield behavior of cohesionless materials [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4644B-4645B, 1969.

Bowen, V. T. *See* Phillips, J. D. 03919

Boyle, R. W. *See* Davies, J. L. 03664

03959 **Boyle, R. W.** Elemental associations in mineral deposits and indicator elements of interest in geochemical prospecting: Canada Geol. Survey Paper 68-58, 45 p., table, 1969.

This report contains numerous data on the elemental associations in all types of mineral deposits and discusses the use of various indicator elements in geochemical prospecting.—Author's abstract

03756 **Boynton, G. R.; Moxham, R. M.** A rapid film-density analyzer, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C123-C126, illus., 1969.

A commercially available electro-optical scan-type copying machine was modified to permit film-density slicing. The electrical circuit changes allow only densities greater than a selected level to be printed and lesser densities to be rejected. One useful application of the instrument is to relate film density, image gray scale, and terrain radiance in the analysis of images from infrared line scanners.—Authors' abstract

04233 **Braddock, William A.** Geology of the Empire quadrangle, Grand, Gilpin, and Clear Creek Counties, Colorado: U.S. Geol. Survey Prof. Paper 616, 56 p., illus., tables, geol. map, 1969.

Bedrock of this quadrangle consists mostly of Precambrian, metasedimentary, metaigneous, and igneous rocks. Prior to completion of metamorphic recrystallization rocks were plastically deformed to produce N-NE trending folds. Boulder Creek Granite and quartz diorite and hornblendite bodies are conformable to these folds. Discordant plutons of Silver Plume Granite were intruded after folding. A period of Precambrian folding, younger than Silver Plume Granite, produced cataclastic rocks and minor superposed folds. Numerous northeast trending faults are marked by flaser gneiss, mylonite, breccia, and gouge; faults were initiated in late Precambrian and reactivated during the Laramide. Tertiary igneous rocks are exposed in the southeastern corner. Two parent magmas, one monzonite and the other granodiorite, developed at about the same time, and differentiated fractions from each were emplaced in an overlapping sequence. —WAB

Bradley, William C. *See* Schumm, Stanley A. 03822

04012 **Bradshaw, R. L.; Sanchez, Florentino.** Migration of brine cavities in rock salt: Jour. Geophys. Research, v. 74, no. 17, p. 4209-4212, illus., 1969.

The theory of Hoekstra and others on migration of liquid inclusions in ice crystals was modified for predicting the migration rates of brine cavities in salt. The driving force for migration is the difference in solubility between the warm and colder sides of the brine cavity. Calculated cavity migration rates for a 1°C per cm gradient ranged from about 0 at 20°C to 7.7 cm per yr at 300°C. Theoretical predictions were found to be in reasonable agreement with migration rates measured in the laboratory. Specimens consisted of relatively pure salt crystals from the Hutchinson, Kansas, mine containing brine cavities between 2 and 10 mm in maximum dimension. Rate measurements were obtained, covering the temperature range 75°-244°C, with gradients ranging from 4° to 34°C per cm. Migration periods varied from about 20 to 358 hours, and observed distances of migration ranged from 0.8 to 8 mm.—*from* Authors' abstract

04071 **Brady, Lawrence L.** Stratigraphy and petrology of the Morrison Formation (Jurassic) of the Canon City, Colorado, area: Jour. Sed. Petrology, v. 39, no. 2, p. 632-648, illus., tables, 1969.

The Morrison Formation is predominantly claystone with interbedded sandstone, siltstone, and thin carbonate units. The maximum thickness is 350 feet. It lies conformably and unconformably upon different units and underlies unconformably the Purgatoire Formation of Cretaceous age. Most of the sandstones are quartzarenites or subarkoses. Calcite and microcrystalline quartz are the cements. Sedimentary rocks were predominant in the source area, and acid igneous and metamorphic rocks contributed minor amounts of detritus. Illite, the most abundant clay, probably came from illite-rich sedimentary rocks; montmorillonite, the predominant clay mineral in the middle Morrison, was formed from altered volcanic ash. Sediments accumulated on floodplains formed by numerous small meandering streams. Deposition of carbonates was in small lakes on low areas of the floodplains. —*from* Author's abstract

Brar, S. S. *See* Kline, J. R. 04286

Brasher, B. R. *See* Nettleton, W. D. 04287

Brasher, B. R. *See* Nettleton, W. D. 04322

Brassell, Gilbert. *See* Schufle, J. A. 04171

04098 **Bretsky, Peter W., Jr.** Evolution of Paleozoic benthic marine invertebrate communities: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 6, no. 1, p. 45-59, illus., tables, 1969.

Three marine benthic communities in the Upper Ordovician of the central Appalachians can be traced throughout part or all of Paleozoic time. Major associations are: (1) linguloid-molluscan (Ordovician-Permian); (2) strophomenid-trilobite (Ordovician-Devonian); (3) atrypid-bryozoan (Ordovician-Devonian); (4) productid-chonetid (Devonian-Permian); (5) fusulinid-palaeotextulariid (Pennsylvanian-Permian). Throughout Paleozoic nearshore communities were consistently dominated by association (1), whereas offshore articulate brachiopod-dominated communities (2-4) underwent more rapid changes in faunal content. A modified form of the Moore-Newell emergence hypothesis does not explain the greater instability of the offshore community. —*from* Author's abstract

Bricker, Owen P. *See* Billings, Gale K. 03852

03891 **Broadbent, Carl D.** Slope stability program of Kennecott Copper Corporation: Soc. Mining Engineers Trans., v. 244, no. 2, p. 209-217, illus., 1969.

In 1956 Kennecott Copper Corp. instituted a slope mechanics program, to obtain efficient and safe pit slopes, with an ultimate goal to minimize the stripping ratio by steepening the slopes to their maximum stable limit. Since then a great deal of research has been conducted, notably at the Kimbley Pit at Ely, Nevada. Reported assumptions and conclusions of the most recent tests and findings of others are presented in summary form, as to concepts of types of failure and status of technology in defining the five primary variables that control the stability of a given rock slope. This paves the way for the next step in the program: refining the design process annd applying it for profit.—GDC

03817 **Brodkorb, Pierce.** An ancestral mourning dove from Rexroad, Kansas: Florida Acad. Sci. Quart. Jour., v. 31, no. 3, p. 173-176, illus., 1968 [1969].

The Rexroad Formation of southwestern Kansas has several important vertebrate faunas covering the time interval near the end of the Pliocene. Evidence is accumulating that all living species of birds arose during the Pleistocene. The mourning dove described (*Zenaidura prior*) here is thought to be ancestral to the modern ones. —ESL

03858 **Brookins, D. G.; Fairbairn, H. W.; Hurley, P. M.; Pinson, W. H.** A Rb-Sr geochronologic study of the pegmatites of the Middletown area, Connecticut: Contr. Mineralogy and Petrology, v. 22, no. 2, p. 157-168, illus., tables, 1969.

These pegmatites have a mineralogy consistent with magmatic origin yet are in a nonigneous area. Rb-Sr age measurements on early minerals suggest 258 ± 1 m.y. Previously reported K-Ar and U-Th-Pb ages are 249 ± 8 m.y. and 260 ± 3 m.y. respectively. Rb-Sr whole-rock data for host rocks vary from 285 ± 10 m.y. to 472 ± 15 m.y. Original Sr isotope ratios in pegmatites and host rocks preclude any genetic relation. Late stage cleavelandites are anomalously enriched in radiogenic Sr-87, the source of which was most probably other zones within the crystallizing pegmatite. This is indicated by analyses of pegmatite whole rocks which show both enrichment and depletion of radiogenic Sr-87 in local systems. There was widespread movement of radiogenic Sr-87 within each pegmatite system, but pegmatite-host rock reactions were minimal.—*from* Authors' abstract

04215 **Brookins, D. G.; Chaudhuri, S.; Dowling, P. L.** The isotopic composition of strontium in Permian limestones, eastern Kansas: Chem. Geology, v. 4, nos. 3-4, p. 439-444, illus., tables, 1969.

The strontium (87/86) ratios in 10 samples of limestones vary from 0.7070 to 0.7091. The reasons may be (1) actual fluctuations in environment in the Permian sea, (2) preferential leaching of radiogenic Sr-87 from argillaceous constituents during the analysis, (3) secondary enrichment of Sr-87 in the limestones due to recrystallization, or (4) some other process or some combination of any of the above.

Comparison of total Sr and silica contents with isotopic Sr (87/86) data indicate no direct correlation between these parameters; hence the range is most probably due to reason (1). Attempts to pinpoint the isotopic composition of Sr on the marine geochron proposed by Hurley (1965) have failed, and the data suggest that methods of determining this geochron are inadequate at present. —*from* Authors' abstract

Brooks, Albert L. *See* Billings, Gale K. 03852

03835 **Brooks, C.; Hart, S. R.; Krogh, T. E.; Davis, G. L.** Carbonate contents and $^{87}Sr/^{86}Sr$ ratios of calcites from Archaean meta-volcanics: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 35-38, illus., table, 1969.

Of 67 Archaean greenstones investigated, 79 percent contained less than 3 percent calcite and 52 percent less than 1 percent calcite. Initial Sr-87/Sr-86 analyses of 14 calcites taken from these rocks indicate that the modification of the greenstone total rock Sr-87/Sr-86 by carbonate development is negligible, providing that vein calcites are distinguished from calcite disseminated through the total rock. The latter, with one exception, record initial Sr-87/Sr-86 ratios of less than 0.703. Strontium in calcite veins has present-day Sr-87/Sr-86 as low as 0.7011 and as high as 0.7179.—Authors' abstract

04103 **Brooks, J.; Shaw, G.** Evidence for extraterrestrial life—Identity of sporopollenin with the insoluble organic matter present in the Orgueil and Murray meteorites and also in some terrestrial microfossils: Nature, v. 223, no. 5207, p. 754-756, illus., 1969.

Some results obtained on Orgueil and Murray seem to establish that the insoluble matter they contain is identical with sporopollenin; criteria on which the identification is based are listed. It is especially noteworthy that the infrared spectrums and pyrolysis gas liquid chromatograms of insoluble organic matter from both meteorites are virtually indistinguishable from each other and from those of morphologically intact microfossil planktonic algal spores *Tasmanites punctatus* and *T. huronensis*. These results, which are completely objective and readily repeatable on quite small amounts of material, are believed powerful evidence for extraterrestrial life; they imply that there was life in the Universe before formation of our planet, and certainly before reworking of the surface 4 b.y. ago, when existence of even reasonably large organic nucleoproteins on Earth would have been most unlikely. —DBV

03986 **Brown, Jim McCaslin.** Structure and origin of the Grenville Front south of Coniston, Ontario [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4709B-4710B, 1969.

04152 **Brown, Richard L.; Dalziel, Ian W. D.; Rust, Brian R.** The structure, metamorphism, and development of the Boothia Arch, arctic Canada: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 525-543, illus., geol. map, 1969.

The Precambrian basement rocks of the arch exhibit three phases of folding characteristic of deep-level deformation in mobile belts. The gneisses contain assemblages of the amphibolite-granulite transitional facies. The arch was a source of clastic sediments during three periods of cover-rock deposition. It was positive in Aston times, and was rapidly uplifted during Late Silurian and Early Devonian to produce continental clastic facies of the Peel Sound Formation. The limited Cretaceous-Tertiary record suggests irregular uplift and localized deltaic sedimentation. The strike of the banding and axial surfaces of folds in the basement parallels the axis of the arch and the axial surfaces of folds in cover rocks. Fracture patterns in the basement and cover rocks are similar. —*from* Authors' abstract

04053 **Brune, James N.; Henyey, Thomas L.; Roy, Robert F.** Heat flow, stress, and rate of slip along the San Andreas fault, California: Jour. Geophys. Research, v. 74, no. 15, p. 3821-3827, illus., 1969.

The absence of a heat flow anomaly greater than about 0.3μ cal per sq cm-sec associated with the San Andreas fault is used to estimate the upper limit for the steady

state of initial shear stress. Under the assumption that the long-term rate of motion along the fault is 5 cm per yr and occurs primarily in the form of creep, this upper limit is about 100 bars. If motion is primarily accomplished by faulting during large earthquakes and if frictional stress is equal to final stress as suggested by E. Orowan (1960), the upper limit is estimated to be about 200 bars. Without Orowan's assumption, the estimation of the upper limit is about 250 bars, based on earthquake energy-magnitude-moment relations. If the long-term rate of motion along the San Andreas fault is only about 2 cm per yr, these results are increased to 250, 350, and 400 bars, respectively. —Authors' abstract

Bruns, H. *See* Perkampus, H. H. 04230

03987 **Bugh, James Edwin.** Geomorphic evolution of the southeastern Sangre de Cristo Mountains, New Mexico [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4710B, 1969.

03937 **Bull, Colin.** The 1978-1980 surge of the Sherman Glacier, south-central Alaska, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 841-843, illus.; discussion, p. 843, 1969.

One third of the ablation area of the Sherman Glacier was covered by a debris sheet resulting from the 1964 Alaskan earthquake. Subsequently observed changes in the mass balance and the movement regime of the glacier lead to the prediction of a surge-type advance in the near future.—Author's abstract

03670 **Bullock, James M.; Wilson, William H.** Gypsum deposits in the Cody area, Park County, Wyoming: Wyoming Geol. Survey Prelim. Rept. 9, 12 p., illus., tables, 1969.

Nearly pure gypsum in a deformed outcrop belt of the Gypsum Spring Formation (Middle Jurassic) is estimated at a million tons. Near Cody there may be 250 million tons no deeper than 250 feet in the subsurface between two plunging anticlines. In Park County this formation is triply divided: lower unit—interbedded gypsum, red shale, minor limestone and dolomite; middle—interbedded fossiliferous limestone, gray shale, calcarenite and gypsum lentils; upper—red shale with basal gypsum. All common varieties of gypsum occur; veins above and below the thickest gypsum of the lower unit are hard and fibrous. A little impure gypsum occurs in the Triassic Dinwoody strata and as fracture fillings in the Chugwater Formation, and also with sulfur in Quaternary, hot spring deposits.—GDC

03920 **Bunce, Elizabeth T.; Fahlquist, Davis A.; Clough, John W.** Seismic refraction and reflection measurements—Puerto Rico outer ridge: Jour. Geophys. Research, v. 74, no. 12, p. 3082-3094, illus., tables, 1969.

Several refraction profiles on the outer ridge north of Puerto Rico, combined with earlier studies, support the presence of an east-west trending structural high or welt on the surface of the mantle. The determinations of shallow mantle depths lie along an east-west line north of a closed free air (20 mgal) gravity high. The trend of the postulated ridge parallels the axis of the Puerto Rico trench and intersects the northwest-trending magnetic lineations reported by other investigators at an angle of 50°.—Authors' abstract

04078 **Burke, K. B. S.** A preliminary interpretation of the crustal structure west of Flin Flon, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 253-262, illus., table, 1969.

Six crustal seismic recordings were made along the Hanson Lake Road, northwest of the Coronation mine. In addition gravity readings were made at one mile intervals. A preliminary interpretation of the seismic data suggests a two layer upper crust with a 6.0 kmps layer overlying a 6.4 kmps layer at 10 km and possibly an increased total thickness of crust of the order of 40 km. This layering in the upper crust may be a feature of the Churchill structural province, as a similar velocity layering has been found in southern Saskatchewan and Alberta. No quantitative interpretation of the gravity

data was attempted, but all anomalies could be satisfactorily explained in terms of changes of rock type in the upper few kilometers of the crust. —*from* Author's abstract

04041 **Burke, Kevin; Freeth, S. J.** A rapid method for the determination of shape, sphericity and size of gravel fragments: Jour. Sed. Petrology, v. 39, no. 2, p. 797-798, illus., 1969.

The lengths of the three major axes of gravel fragments can be determined by placing the fragments over a grid on an overhead projector of the type found in most modern lecture theaters. —Authors' abstract

Burnett, D. S. *See* Wasserburg, G. J. 04005

03879 **Burwash, R. A.** Comparative Precambrian geochronology of the North American, European, and Siberian shields: Canadian Jour. Earth Sci., v. 6, no. 3, p. 357-365, illus., 1969.

A comparison of U-Pb, Rb-Sr, and K-Ar isotopic dates suggests three major orogenies common to all areas. U-Pb and Rb-Sr dates suggest mean values of 2600 ± 100, 1800 ± 100, and 1000 ± 100 m.y. An earlier event at 3300 to 3500 m.y. is locally recognizable in the Baltic, Ukrainian, and southern Canadian shields. Isotopic dates are divided into anorogenic and orogenic, and the orogenic is further divided into precrystalline, syncrystalline, and postcrystalline. Rigorous statistical treatment seems unwarranted on the basis of the uncertainties in the geologic history of most rock bodies. Histograms may aid in the identification of anorogenic and precrystalline dates.—*from* Author's abstract

03703 **Buseck, Peter R.** Phosphide from meteorites—Barringerite, a new iron-nickel mineral: Science, v. 165, no. 3889, p. 169-171, illus., table, 1969.

Schreibersite and a higher phosphide, barringerite, occur in the Ollague pallasite. The composition of barringerite, as determined by electron microprobe analysis, is given. The mineral is hexagonal, with space group $P\bar{6}2m$ and $a = 5.87 \pm 0.07$ A and $c = 3.44 \pm 0.04$ A. If of primary origin, the new mineral indicates that troilite and schreibersite crystallized at high temperatures. The occurrence of a higher phosphide in a pallasite indicates local nonequilibriums within a group of meteorites that are remarkable for their overall degree of equilibrium crystallization.—DBV

04127 **Byerly, Perry.** Seismic intensity scales: Seismol. Soc. America Bull., v. 59, no. 4, p. 1735, 1969.

Every now and then it is recommended that intensity evaluations now made should be suppressed when quantitative measures of earthquake strength are devised. Whatever the originators of intensity scales expected of them, their purpose today is to describe what happened. This history must be preserved. It should be remembered that one set of strong-motion seismographs in one basement in a public building in a town will never give a total picture of what happened throughout that town. —DBV

Byers, A. R. *See* Scott, B. P. 04080

04092 **Byers, A. R.** The Coronation mine project, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 1-5, 1969.

In this area, volcanic and sedimentary rocks were intruded by igneous rocks and metamorphosed, and a north-northeast trending fault system was created. The Coronation deposits occur within shear zones in the metamorphic rocks of the volcanic complex, and consist of three ore shoots within a zone of low-grade mineralized rock which is 900 by 120 by 1000 feet in size. The three ore shoots and mineralized zone plunge steeply south. Two ages of mineralization are recognized: an older pyrite-sphalerite-pyrrhotite-chalcopyrite and a younger tetrahedrite-chalcopyrite-calcite type. Wallrock alteration is somewhat variable and not extensive. The deposit has had a long and complex history. —HRC

04094 **Byers, A. R.** (editor). Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, 329 p., illus., tables, 1969.

This is a collection of seventeen papers (cited separately) on various aspects of the geology, geophysics, and geochemistry of the Coronation mine, in the Flin Flon region of Saskatchewan. —HRC

03737 **Caddie, George H.** An analysis of some data from natural alluvial channels, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C188-C194, illus., 1969.

Recent work on the geometry of stream channels has resulted in a hypothesis that the friction factor of any stream flowing in alluvium is virtually indeterminate because friction is the result of specific constraints placed upon the stream. The relationships between velocity, unit discharge, and slope for several locations on the Colorado River below Glen Canyon Dam are different from those of channels in which depth, velocity, and discharge all vary with changes in load and discharge. Apparently this is so because the stream is degrading its bed at these locations. Some natural streams, unaffected by man-made reservoirs, are shown to have the same characteristics. —Author's abstract

03727 **Cadle, R. D.; Lazrus, A. L.; Shedlovsky, J. P.** Comparison of particles in the fume from eruptions of Kilauea, Mayon, and Arenal volcanoes: Jour. Geophys. Research, v. 74, no. 13, p. 3372-3378, illus., tables, 1969.

The physical and chemical properties of particles collected from the eruption fume of Kilauea, Mayon, and Arenal volcanoes were determined by colorimetric chemical techniques, neutron activation, atomic absorption, X-ray diffraction, an electron microprobe, and electron microscopy. More than 95 percent of Kilauea particles were largely dilute sulfuric acid droplets plus some mainly needle-like crystals, which previously had been tentatively identified as S and Ca and a...nonium sulfates. Wet chemical analysis demonstrated the presence of soluble Ca, ammonium, and Mg sulfates. Each type of particle observed at Kilauea was also observed at Mayon, but most droplets from Mayon were much less acidic. Mayon particles of "ash" or minute spheres were not observed at Kilauea. Particles in the fume from Arenal were more like those from Mayon.—*from* Authors' abstract

04082 **Cairns, R. B.** Calculation of ore reserves in the Coronation mine, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 321-329, illus., 1969.

The ore body was divided into 25 blocks for a volume and grade estimate which gave a reserve figure of 825,000 tons at 5.08 percent Cu. Developmental work and drilling of 261 holes provided more data for re-estimation and gave a figure of 722,000 tons at 4.83 percent Cu. Subsequent revisions involved up to 150 blocks. When the ore body was mined out, total production was 1,412,861 tons at 2.25 percent Cu, which yielded 43 percent more Cu than originally estimated. In view of this, it does not seem that a computerized data processing technique is warranted in the evaluation of a deposit of this size and type because the number of individual ore reserve blocks is comparatively small and the greater part of the estimating procedure is interpretive. —*from* Author's abstract

04279 **California Dept. Water Resources.** Ground-water measurements, *in* Hydrologic data, 1967—V. 5, Southern California: California Dept. Water Resources Bull. 130-67, v. 5, App. A-C, p. 91-449, illus., tables, 1969.

This appendix contains: ground-water level measurements for approximately 8,000 wells for the period October 1, 1966, through September 30, 1967; hydrographs of selected wells; and a tabulation of ground-water replenishment. —MCM

Calvin, Melvin. *See* Han, Jerry. 03969

Campbell, A. T., Jr. *See* Lebourg, M. 04301

03988 **Campbell, Donald Harvey.** Petrology of the Early Cretaceous Yucca Formation, southern Quitman Mountains and vicinity, Trans-Pecos Texas [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4710B, 1969.

03926 **Campbell, William J.; Rasmussen, Lowell A.** Three-dimensional surges and recoveries in a numerical glacier model, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 979-985, illus.; discussion, p. 985-986, 1969.

The Navier-Stokes equation, integrated vertically to yield a two dimensional transport equation, is combined with the three-dimensional continuity equation. By assuming a linear relation between volume transport and bottom shear stress, a system of numerically tractable differential equations is developed that contains a nonlinear surface slope term and a term in which horizontal frictional forces are stated explicitly. Since no quantities such as ice velocities are used, only an arbitrary bed configuration and net-balance vs. altitude curve need be added. By reducing bed friction over the entire glacier for one year, surges are induced; a five percent reduction only is needed to produce typical surges. The original steady state shape is approached asymptotically, with total recovery taking hundreds of years.—*from* Authors' abstract

04095 **Canada Geological Survey.** Aeromagnetic series, Kenora, Manitoba-Ontario: Canada Geol. Survey Geophysics Paper 7106, scale 1:253,440, 1969.

04096 **Canada Geological Survey.** Aeromagnetic series, Bonaparte Lake, British Columbia: Canada Geol. Survey Geophysics Paper 7716, scale 1:253,440, 1969.

04097 **Canada Geological Survey.** Aeromagnetic series, Grand Rapids, Manitoba: Canada Geol. Survey Geophysics Paper 7740, scale 1:253,440, 1969.

04206 **Canada Geological Survey.** Abstracts of publications in scientific journals by officers of the Geological Survey of Canada, April 1968 to March 1969: Canada Geol. Survey Paper 69-4, 47 p., 1969.

This report contains abstracts of 88 papers published by officers of the Geological Survey of Canada in scientific journals and books during the period 1 April, 1968 to 31 March, 1969. Most of these papers included abstracts, and these have been copied from the published texts; abstracts for the others were prepared by the authors concerned. The abstracts of the papers are arranged alphabetically according to author. —*from* introduction

03909 **Capon, J.** Investigation of long-period noise at the large aperture seismic array: Jour. Geophys. Research, v. 74, no. 12, p. 3182-3194, illus., tables, 1969.

An investigation was made to determine the sources and properties of the seismic noise in the 20- to 40-second period range at the large aperture seismic array (LASA) in Montana. The conventional and high-resolution frequency-wave number spectra are presented for the noise, as well as coherence results. These data show that the noise consists of two components. One component propagates across the array as fundamental-mode Rayleigh waves and is believed to be caused by the action of surf on coastlines. The other component is nonpropagating, or incoherent, noise; some of its properties are discussed.—Author's abstract

03974 **Capon, J.; Greenfield, R. J.; Lacoss, R. T.** Long-period signal processing results for the large aperture seismic array: Geophysics, v. 34, no. 3, p. 305-329, illus., tables, 1969.

Results of off-line signal processing experiments are presented for long-period data obtained from the Large Aperture Seismic Array in eastern Montana. The signal-to-noise ratio gains are presented for body-wave as well as surface-wave phases. Several recommendations are made concerning optimum long-period array configurations and on-line or off-line processing methods. The usefulness of maximum likelihood processing in suppressing an interfering teleseism is demonstrated. The matched fil-

tering of surface waves using chip waveforms is shown to be highly effective. A useful discriminant for distinguishing between natural seismic events and underground nuclear explosions, using both long-period and short-period data, was found to be the relation between surface-wave and body-wave magnitudes. Measurements of this discriminant made on events from four tectonic regions of the Earth are presented. —*from* Authors' abstract

Card, K. D. *See* Fairbairn, H. W. 03871

04281 **Carey, Walter C.** Formation of flood plain lands: Am. Soc. Civil Engineers Proc., v. 95, paper 6574, Jour. Hydraulics Div., no. HY 3, p. 981-994, illus., 1969.

Alluvial rivers migrate laterally and longitudinally, generating new floodplain lands in four types of accretion:sheet, point bar, eddy, and back-swamp. The type of floodplain land generated is determined by the nature of the local river migration or movement. Incident to migration, caving banks are formed, and under certain conditions caves can be very sudden, extensive, and dangerous to man, should the area involved be developed or urban. Studies of river migrations and the resulting flood plain lands represent the most generalized aspect of river hydraulics and sedimentation studies. In the present studies, mode of formation is the controlling criterion; such matters as nature of sediment, types of soil, kind of stratification or other detailed concerns, are of no moment. —*from* ASCE abstract

Carmichael, I. S. E. *See* Nicholls, J. 03683

03868 **Carpenter, Alden B.; Miller, John C.** Geochemistry of saline subsurface water, Saline County (Missouri), *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 135-167, illus., tables, 1969.

The chemical character of this water is largely mineralogically controlled. The water is supersaturated with respect to quartz; the silica concentration is held constant at approximately 9 ppm apparently by the dissolution of illite. Potassium and H ions have a markedly different relationship to variations in salinity than do other Group Ia elements, being controlled by clays. The water is approximately saturated with respect to calcite and dolomite, so that variations in the Ca/Na and Mg/Na ratios are due to the addition or subtraction of water from the system affecting the Na whereas the Ca and Mg are additionally affected by the equilibrium with calcite and dolomite. The water is saturated with respect to $SrCO_3$ and $BaCO_3$ in some form and the Sr/Ba activity ratio is mineralogically controlled. Composition cannot be used to determine origin of salinity.—*from* Authors' summary

03885 **Carter, Neville L.; Raleigh, C. Barry.** Principal stress directions from plastic flow in crystals: Geol. Soc. America Bull., v. 80, no. 7, p. 1231-1264, illus., 1969.

Methods for determining orientations of principal stress axes in deformed rocks involve dynamic analysis of twin-gliding and of extinction bands produced by inhomogeneous translation gliding in crystals. Using as guides the results from laboratory experiments on various rock-forming minerals, the methods are discussed in detail and applied to tectonites. Observed orientations of principal stresses around folds are evaluated with reference to a theoretical analysis of large amplitude folding of viscous layers in a less viscous medium.—AG

Cash, Daniel J. *See* Sanford, Allan R. 03772

04123 **Casshyap, Satyendra M.** Petrology of the Bruce and Gowganda Formations and its bearing on the evolution of Huronian sedimentation in the Espanola-Willisville area, Ontario (Canada): Palaeogeography, Palaeoclimatology, Palaeoecology, v. 6, no. 1, p. 5-36, illus., table, 1969.

The Bruce Formation is a massive, unstratified diamict—a pebbly conglomeratic muddy sandstone. The Gowganda has four mappable units, a lower diamict, laminated argillite, upper diamict, and an upper intercalated zone of sandstone, argillite, and conglomerate. Texturally and compositionally the two formations are alike.

Evidence from dimensional fabric, paleocurrents, and petrography suggest a northerly sediment transport for the two formations, and a source area composed of granites and volcanic-schistose complex in the Canadian shield. Both the diamicts are of glacial origin and these deposits were laid down probably from wet-base glaciers in a terrestrial environment. Evidence from Huronian succession has been used to interpret the relative rate of subsidence, eustatic sea-level changes, isostatic adjustment, and climatic changes. —*from* Author's abstract

03667 **Cater, Fred W.** The Cloudy Pass epizonal batholith and associated subvolcanic rocks: Geol. Soc. America Spec. Paper 116, 54 p., illus., tables, geol. map, 1969.

The Cloudy Pass batholith, consisting largely of labradorite granodiorite, discordantly intrudes pre-Late Cretaceous rocks in north-central Washington. The small batholith is remarkable for its chilled borders, associated porphyry plugs, and intrusive breccias. It is bordered on the northeast by the 1.5-mi-thick chilled complex of Hart Lake that consists of separately injected, contrasting layers of dacite and labradorite-bytownite andesite porphyries and autobreccias. Porphyry plugs, largely dacite, puncture the adjacent metamorphic rocks. Intrusive breccias are of two types, one confined to the core of the batholith, the other, apparently injected explosively, confined to the porphyry plugs and gneiss. Plagioclases range from high- to low-temperature; the low-temperature form, in the batholith core and in the complex, is thought to have inverted from original high-temperature.—*from* Author's abstract

03659 **Cayeux, Andre de.** Three billion years of life: New York, Stein and Day, 239 p., illus., 1969; originally published in French, 1964.

This book consists of a preface (terrestrial evolution, a cosmic phenomenon), introduction (a mystical communion), and three parts: (1) development of living matter—fossils and dates, proof of evolution, origin of life; (2) from crystal to man —stages of life, evolutionary process, evolutionary tendencies; and (3) accelerated life—faster and faster, theories of evolution, and conclusion. An 18-page glossary and an index are included.—MCM

03796 **Chang, Luke L. Y.** Rare earth substitution in scheelite: Jour. Inorganic and Nuclear Chemistry, v. 31, no. 7, p. 2003-2014, illus., 1969.

Substitution of calcium in scheelite by lanthanum and samarium with or without sodium was studied at temperatures between 660° and 1150°C. In the systems formed by substituting La or Sm, complete series of solid solutions form above 1020°C, but in each system a phase boundary separates tetragonal and monoclinic defect scheelite; with Na for part of the La and Sm, immiscibility gaps disappear at 825°C and there is no detected phase change in the solid solutions. In the ternary system with both Na and La, at 750°C a three-phase region (tetragonal, tetragonal disordered and monoclinic defect scheelite) occupies the center of the phase diagram. At 900°C, scheelite with either disordered or defect scheelite is the major phase assemblage; at 1025°C, there are only one-phase regions, the tetragonal solid solution transforming to the monoclinic with increasing lanthanum tungstate.—VSN

04009 **Chang, Z. P.; Barsch, G. R.** Pressure dependence of the elastic constants of single-crystalline magnesium oxide: Jour. Geophys. Research, v. 74, no. 12, p. 3291-3294, illus., tables, 1969.

New precision measurements have been made of the pressure dependence of the elastic constants of MgO single crystals by using the ultrasonic pulse superposition method in connection with an automatic peak finder. The results for the first pressure derivatives of the elastic constants lie mostly between the earlier data of Bogardus and the data of Anderson and Andreatch and essentially agree, within the joint experimental error, with both sets of values.—Authors' abstract

04139 **Chase, M. E.** Airborne remote sensing for groundwater studies in prairie environment: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 737-741, illus., 1969.

Prairie land in southern Alberta was surveyed by airborne remote sensors. Panchromatic and black and white true infrared photography were found to be of limited value. An infrared scanning survey, using the 2.5-5.6 μ band was flown at the same time and found to be more informative. Till covers most of the area, with lake deposits in the eastern section. Soil moisture changes were registered on the imagery, but the depths of overburden to which these changes were recorded on the surface are unknown, due to the condition variations between the time of the survey and the drilling. Vegetation, surface water, soil moisture, and saline sloughs were found to have the strongest thermal signatures. Problems encountered in the survey are discussed. —*from* Author's abstract

Chaudhuri, S. *See* Brookins, D. G. 04215

Chenoweth, P. A. *See* Disney, R. W. 04302

Cherry, J. A. *See* Newbury, R. W. 04158

04330 **Chichester, F. W.; Youngberg, C. T.; Harward, M. E.** Clay mineralogy of soils formed on Mazama pumice: Soil Sci. Soc. America Proc., v. 33, no. 1, p. 115-120, tables, 1969.

Samples of the <2μ fraction in central Oregon had mineral suites consisting predominantly of X-ray amorphous material in combination with a rather complex group of 2:1 phyllosilicates, gibbsite, felspars, and quartz. The factors primarily controlling clay mineral genesis were hypothesized to be the vesicular structure and chemical composition of the pumiceous parent material. —Editor's brief

03855 **Chilingarian, George V.; Rieke, Herman H., 3d.** Some chemical alterations of subsurface waters during diagenesis, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 235-252, illus., tables, 1969.

A brief review of some processes which affect the chemical composition of interstitial waters is presented. The experimental results obtained by the writers indicate that the mineralization of squeezed-out solutions progressively decreases with increasing overburden pressure. Possibly, as the underground waters move through a thick shale sequence, the mineralization could increase to levels found in oil-field brines; the Ca/Cl and Ca/Na ratios *could*, but not necessarily, also increase. —Authors' summary

03713 **Chinnery, Michael A.** Velocity anomalies in the lower mantle: Physics Earth and Planetary Interiors, v. 2, no. 1, p. 1-10, illus., 1969.

Observations of the slope of the traveltime curve have been made on the P-wave arrivals at the Large Aperture Seismic Array from about 400 events at a northwesterly azimuth from the array. A velocity structure for the lower mantle is deduced using the Wiechert-Herglotz formula. Regions of anomalous velocity change are found to occur in the vicinity of 700, 1150, and 2000 km depth, and there is a possibility of an additional anomaly at about 2500 km.—Author's abstract

Christensen, C. J. *See* Eyring, H. 04261

Christodoulides, C. *See* Durrani, S. A. 04169

03889 **Christopher, Peter A.** Fission track ages of younger intrusions in southern Maine: Geol. Soc. America Bull., v. 80, no. 9, p. 1809-1813, illus., table, 1969.

Fission track ages were obtained for ten apatite concentrates from six post-Paleozoic stocks in southern Maine to check reliability of the method in post-Paleozoic terranes, establish an age for the youngest igneous event, and check correlation of the Burnt Meadow and Agamenticus Complexes with the White Mountain plutonic-volcanic series. A mean age of 119 ± 9 m.y. was obtained from Cape Neddick Gabbro, Tatnic Complex, alkaline syenite at Litchfield, Maine, and Abbott Mountain Syenite. Ages of 116 m.y. from the Agamenticus and 143 m.y. from the Burnt Meadow Com-

plex reflect the low annealing temperature for fission tracks in apatite. Ages of 177 m.y. from the Burnt Meadow and 172 m.y. from Agamenticus Complexes support correlation with the White Mountain plutonic-volcanic series established as 180 ± 5 m.y.—*from* Author's abstract

03850 **Chung, D. H.; Simmons, Gene.** Pressure derivatives of the elastic properties of polycrystalline quartz and rutile: Earth and Planetary Sci. Letters, v. 6, no. 2, p. 134-138, tables, 1969.

Ultrasonic measurements at 298°K as a function of hydrostatic pressure at 7 kb for polycrystalline quartz and rutile yield values, here tabulated, of pressure coefficients of compressional (P) and shear (S) waves, the adiabatic bulk modulus K_S, and its isothermal pressure derivatives. These data are discussed in relation to the structure and the phase instability at high pressure. The relatively small values of $(\delta \ln V_S/\delta P)_T$ may indicate that neither high thermal gradient nor partial melting is required to account for the low-velocity layer in the Earth.—*from* Author's abstract

Church, Richard E. *See* Péwé, Troy L. 03666

03923 **Clark, H. C.** Remanent magnetization, cooling history, and paleomagnetic record of the Marys Peak sill, Oregon: Jour. Geophys. Research, v. 74, no. 12, p. 3143-3160, illus., table, 1969.

A paleomagnetic investigation of the middle Oligocene (29.6 m.y.) Marys Peak sill (44°30′ N., 123°35′ W.) demonstrates a relation between the cooling history of the intrusion and its remanent magnetization. The 390-m-thick sill is vertically differentiated. Directions and intensities of remanent magnetization were measured for all specimens at the original magnetization level and after a-c demagnetization. Directions of natural remanent magnetization at individual sites are well grouped and significantly different from the present field. Results indicate that the range of the paleomagnetic record is approximately 2,000 to 6,000 years; the change in remanent magnetization direction could have been caused by a large nondipole field component or an excursion of the main dipole field.—*from* Author's abstract

04180 **Clark, J. F.** Magnetic profiles at Holleford Crater, eastern Ontario [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 24-29, illus., tables, 1969.

Comparison is made of airborne and surface measurements of the geomagnetic total field over Holleford Crater, a circular feature 1.4 miles in diameter in eastern Ontario which may be of meteoritic origin. The attenuation of magnetic anomalies observed at an altitude of 500 feet as compared to ground observations is studied along four profiles across the crater. An unusual circumstance, in which an anomaly apparently increases with altitude, is discussed. —Author's abstract

03844 **Clarke, W. B.; Beg, M. A.; Craig, Harmon.** Excess ^{3}He in the sea—Evidence for terrestrial primordial helium: Earth and Planetary Sci. Letters, v. 6, no. 3, p. 213-220, illus., table, 1969.

A sample of Pacific water from 1737 m shows 21.8 ± 2.1 percent excess He-3, and deeper samples range from 5.8 ± 1.9 percent to 12.2 ± 2.0 percent, whereas a surface sample and one from 866 m show identical He-3/He-4 as compared with air. The total He is in excess by -3 ± 3 percent to 8 ± 3 percent relative to solubility data. There appears to be a rough correlation between He-3 excess and He-4 excess indicating that there are two components in varying proportions, one with atmospheric He isotope ratio and another with a considerably higher ratio. The excess He-3 is due to leakage into ocean water of a remnant of the Earth's primordial He-3. There appears to be no other possible mechanism.—*from00* Authors' abstract

03719 **Closmann, P. J.** On the prediction of cavity radius produced by an underground nuclear explosion: Jour. Geophys. Research, v. 74, no. 15, p. 3935-3939, illus., tables, 1969.

A correlation has been developed between the cavity produced by a contained underground nuclear explosion and other variables, including explosive yield, overburden density, depth of burial, and the Young's and shear noduli. An equation is obtained, based on published results for 46 nuclear events, which calculates cavity radius for these events with an average error of 7.8 percent. Some predictions by this method compare reasonably well with those by other methods for media for which there is no previous experience.—Author's abstract

03684 **Cloud, P. E., Jr.; Licari, G. R.; Wright, L. A.; Troxel, B. W.** Proterozoic eucaryotes from eastern California: Natl. Acad. Sci. Proc., v. 62, no. 3, p. 623-630, illus., 1969.

Both procaryotic and eucaryotic nannofossils occur in chert from the upper Beck Spring Dolomite (Pahrump Group) in northeastern San Bernardino County, Calif. These fossils include the oldest reasonably certain records to date of chlorophycean and chrysophycean algae, and hence of the eucaryotic or mitosing cell. Associated with these are cyanophycean procaryotes of still more ancient affinities. Indirect radiometric evidence implies an age of 1.2 to 1.4 aeons (1.2 to 1.4×10^9 years) for the enclosing rocks. Associated stromatolites are consistent with such an age assignment.—Authors' abstract

Clough, John W. *See* Bunce, Elizabeth T. 03920

Coates, J. A. *See* Frebold, Hans. 03663

03661 **Cole, W. Storrs.** Internal structure, stratigraphic range and phylogenetic relationships of certain American Eocene Foraminifera: Cushman Found. Foram. Research Contr., v. 20, pt. 3, p. 77-86, illus., 1969.

The internal structure of topotypes of *Camerina catenula* (Cushman and Jarvis) and *Eoconuloides parvulus* (Cushman) and of specimens of *Eoconuloides wellsi* Cole and Bermudez and *Helicostegina polygyralis* (Barker) is discussed and illustrated and notes are given on their stratigraphic ranges. In the introductory remarks a postulate by Hofker (1968) concerning the phylogenetic relationship of the genus *Lepidocyclina* and related genera is rejected. *Lepidocyclina ecuadorensis* Hofker is without question a synonym of *Helicolepidina spiralis* Tobler. The phylogenetic relationships proposed by Barker and Grimsdale (1936) for the lepidocycline and helicolepidine lineages are maintained and re-emphasized.—Author's abstract

03842 **Collins, A. Gene.** Chemistry of some Anadarko basin brines containing high concentrations of iodide, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 169-187, illus., tables, 1969.

Rocks of Mississippian and Pennsylvanian age were tested, and the brines contain the highest concentrations of iodide ever recorded. The brines are a Na-Ca-Cl type, from Pennsylvanian rocks. The bromide concentrations indicate that they are probably relict. The Mg^1/Mg ratios indicate that some of the brines were in equilibrium with sandstones, some with dolomites, and some with limestones. Compared with evaporated sea water, most are enriched in bromide, Ca, Li, Sr, and iodide, and depleted in Mg and K. Most of the brines from Mississippian age rocks were enriched in B whereas those from Pennsylvanian age rocks were depleted in B. The high iodide concentration is attributed to concentration by an abundant shallow water ancient fauna and flora and preservation by rapid sedimentation; more iodide came from concentration by later compaction. —*from* Author' summary

03689 **Collins, Earl M.; Kesler, Stephen E.** High temperature telescoped tungsten-antimony mineralization, Guatemala [with German abs.]: Mineralium Deposita, v. 4, no. 1, p. 65-71, illus., 1969.

An area of unusual stibnite and scheelite mineralization was encountered while mapping near Ixtahuacan. Ore is localized along two intersecting faults in the upper part of the Pennsylvanian-Permian Tactic shale, and seems to be a telescoped xenothermal deposit. Source of the tungsten-antimony-bearing solutions is uncertain, but it might be a volcanic center less than 4 km south. It is suggested that this deposit

formed at 400 to 500°C by rapid reaction between the alkaline hydrothermal solution and Chochal limestone or calcareous layers in shale. This constrasts with similar deposits which contain minerals thought to form at lower temperatures by a rapid decrease in temperature. Strontium isotopic evidence on Guatemalan volcanic rocks like those thought to be the source of the metallization suggests that the metals had their source in the upper mantle or lower crust.—*from* Authors' abstract

03979 **Collins, Gary Brent.** Implications of diatom succession in postglacial sediments from two sites in northern Iowa [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4546B, 1969.

04029 **Compston, W.; Oversby, V. M.** Lead isotopic analysis using a double spike: Jour. Geophys. Research, v. 74, no. 17, p. 4338-4348, illus., tables, 1969.

Variable mass discrimination limits the accuracy of lead isotopic analysis by single-filament surface ionization. It can be corrected to an accuracy of 0.1 percent by making an additional mass analysis of the sample mixed with a double Pb-204, Pb-207 tracer. The principles of the method are described and its use is illustrated by replicate analysis of the California Institute of Technology common lead standard. Its accuracy is determined by the calibration of the Pb-204/Pb-207 of the spike, which is here based on the National Bureau of Standards equal atom Pb standard and by a comparison of the fractionation corrected CIT ratios with those observed by E. J. Catanzaro (1968). —Authors' abstract

03701 **Condie, Kent C.; Kuo, C. S.; Walker, R. M.; Murthy, V. Rama.** Uranium distribution in separated clinopyroxenes from four eclogites: Science, v. 165, no. 3888, p. 57-59, illus., table, 1969.

Uranium concentrations and distribution in separated clinopyroxenes of eclogites from four different sites have been studied by the fission track method. Samples from different localities vary in their average uniformly distributed U concentration by a factor of about 1000 (from 0.01 to 20 ppb of U). The clinopyroxenes from the only oceanic locality studied (Salt Lake Crater) contained both the largest concentration and most uniform distribution of U. This study suggests that, if total U concentrations in eclogitic clinopyroxenes are less than a few ppb, much if not most of the U may occur as contaminants along cracks or in microinclusions of unknown origin.—*from* Authors' abstract

03846 **Condie, Kent C.; Heimlich, R. A.** Interpretation of Precambrian K-Ar biotite dates in the Bighorn Mountains, Wyoming: Earth and Planetary Sci. Letters, v. 6, no. 3, p. 209-212, illus., 1969.

The K-Ar age distribution pattern for biotite in the Precambrian core of the Bighorn Range suggests that contours of equal K-Ar mineral age in small geographic areas may represent fossil contours of equal argon retention rather than fossil thermochrons.—Authors' abstract

04065 **Cook, David O.** Calibration of the University of Southern California automatically recording settling tube: Jour. Sed. Petrology, v. 39, no. 2, p. 781-786, illus., tables, 1969.

The automatically recording settling tube at the University of Southern California was calibrated using small groups of glass beads. The settling times were adjusted to a specific gravity of 2.65 and the calibration extrapolated for different temperatures. The calibration does not compensate for interaction among settling grains, but this factor may significantly influence the deposition of aqueous sands. The range of calibration and laboratory error for the settling tube is small compared to the textural variation of natural sands. —Author's abstract

03743 **Cooper, Kenneth R.** A rapid, accurate method of mapping tunnels of circular cross section: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 63-68, illus., tables, 1968 [1969].

The use of boring machines for tunnel excavating presents unusual problems in tunnel mapping. The method used by the U.S. Bureau of Reclamation on the San Juan-Chama project consists of recording geologic observations at the underground station on a portable tape recorder. All planar structures are related to three points—two points of equal elevation on each side of the tunnel at the spring line and the third point in the crown on the center line. The typed transcription of the recording serves as a permanent record of the geologist's observations. The geologist who makes the observation plots and projects recorded geologic data on standard forms representing a plane through spring line and planes tangent to the spring line. Mathematical tables are prepared for specific diameter tunnels and used for determining the dip of the structure.—*from* Author's abstract

Cox, R. A. *See* Newbury, R. W. 04158

03790 **Craig, Alan J.** Vegetational history of the Shenandoah Valley, Virginia, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 283-296, illus., tables, 1969.

Two pollen diagrams from Hack and Quarles Ponds, in the southern part of the Shenandoah Valley, Va., show the following pollen assemblage zones: (1) a basal *Pinus-Picea* zone with abundant conifers and large amounts of herbs, with two subzones, the top being 12,720 ± 200 yr B.P.; (2) a *Quercus* zone, with very little conifer and two subzones, the upper being 9520 ± 200 yr B.P.; (3) a *Quercus-Pinus* zone with substantial amounts of other deciduous tree pollen. These diagrams strongly resemble those from southeastern Virginia and North Carolina and differ markedly from those farther north in areas covered by Wisconsin ice. Substantial changes in vegetation occurred at considerable distances from the ice sheets. There is support also for the hypothesis that the Appalachians served as a refuge for *Pinus* and *Picea* during at least part of Wisconsin time.—*from* Author's abstract

Craig, Harmon. *See* Clarke, W. B. 03844

03870 **Crain, I. K.** A simple method of calculating climatic corrections to heat flow measurements: Canadian Jour. Earth Sci., v. 6, no. 3, p. 499-502, table, 1969.

A series approximation for calculating climatic corrections to include the effect of all of the Pleistocene glaciations is derived. The method is useful for boreholes less than 1,200 m deep, and only two terms of the series are required for depths less than 600 m. About 70 percent of the effect at the surface is a result of the most recent deglaciation and this percentage increases with depth.—Author's abstract

04257 **Crain, I. K.; Crain, P. L.; Plant, M. G.** Long period Fourier spectrum of geomagnetic reversals: Nature, v. 223, no. 5203, p. 283, illus., 1969.

The normalized Fourier power spectrum of the proportions of normal polarity measurements during Phanerozoic time has been calculated from data compiled by Simpson (1966), using the time scale of Harland (1964). Two major components in the vicinity of 300 and 80 m.y. respectively reflect magnetic polarity episodes of approximately half these durations. The term "magnetic era" is proposed to describe polarity epochs of about 150 m.y. duration, and "magnetic period" is suggested for episodes of about 40 m.y. The periodic behavior noted here cannot be explained simply in terms of the self-excited dynamo model, but Cox's (1968) model could be modified to account for the observations. An apparent correlation between galactic oscillations and observed geomagnetic periods may indicate an external cosmologic influence on the geomagnetic field. —DBV

Crain, P. L. *See* Crain, I. K. 04257

04164 **Crandell, Dwight R.** The geologic story of Mount Rainier—A look at the geologic past of one of America's most scenic volcanoes: U.S. Geol. Survey Bull. 1292, 43 p., illus., tables, 1969.

The volcanic and glacial histories of Mount Rainier are summarized for the layman. The following are discussed: the changing landscape of 12-60 m.y. ago; thumbnail biography of Mount Rainier; results of recent eruptions; why glaciers,; work habits of glaciers; yesterday's glaciers; landslides and mudflows—past, present, and future; the volcano's future; and further reading in geology. Renewed activity of this volcano is to be expected in the future but, if eruptions are on a scale similar to that of the past 10,000 years, the greatest hazards would be from indirect effects of avalanches and mudflows. —VSN

04008 **Creer, K. M.** Comments on paper by J. L. Roy, N. D. Opdyke, and E. Irving, "Further paleomagnetic results from the Bloomsburg Formation" [1967]: Jour. Geophys. Research, v. 74, no. 12, p. 3299-3302, illus., 1969.

The pole obtained from the "intermediate" group of Bloomsburg directions lies among poles taken to represent the lower Paleozoic field. Roy, Opdyke, and Irving (ibid., v. 72, no. 20, p. 5075-5086, 1967) suggested that these directions represent incompletely cleaned samples belonging to the "northerly" group. Although they recongized the existence of the intermediate directions as a distinct group, they attached no significance to this group and neglected to calculate its pole. It is suggested here that its mean pole, determined by 23 out of the 32 intermediate samples as 104° E., 9° S., may represent the Silurian geomagnetic field. If assessed in isolation from other paleomagnetic work, conclusions of Roy, Opdyke, and Irving represent a reasonable but not unique interpretation; in a wider context, including data for the Paleozoic of other continents, the arguments favor the interpretation advanced here. —DBV

Criner, James H. *See* Wilson, John M. 04326

04135 **Crozier, W. D.** Direct measurement of radon-220 (thoron) exhalation from the ground: Jour. Geophys. Research, v. 74, no. 17, p. 4199-4205, illus., tables, 1969.

A method has been devised for direct measurement of the Rn-220 flux through the ground surface (exhalation), and measurements are reported for six sites. At one site comparisons are made between the measured exhalation and those exhalations deduced from Rn-220 profiles in the air above the site; agreement is good with low intensity of turbulence. The discrepancies with higher turbulence are discussed. —Author's abstract

03989 **Curran, Harold Allen.** Upper Cretaceous Foraminifera and subsurface stratigraphy of the southeastern North Carolina Coastal Plain [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4711B, 1969.

03823 **Curry, Robert R.** Holocene climatic and glacial history of the central Sierra Nevada, California, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 1-47, illus., 1969.

A chronology based on geologic deposits dated by radiocarbon and lichenometry, variation in tree rings, changes in timberline position, vegetational age classes, and direct and indirect historical records shows four major periods of increased mean snowfall and cooler, cloudier summers during the last 10,000 years resulting in four periods of multiple glacial advance. These occurred between 6000 and 7000 years ago, 2000 and 2600 years ago, around 1000 years ago, and between 650 years ago and the present. The fluctuations from glacial to interglacial climate that are presently known to have occurred during the last 8000 years can be fully explained by a climatic model in which the extremes of mean precipitation of the 96 years of historical record are greater than the range of long term means for that climatic parameter.—*from* Author's abstract

Cushman, R. V. *See* Krieger, R. A. 03691

04197 **Cuzon du Rest, R. P.** Films on oceanography: U.S. Natl. Oceanog. Data Center Pub. C-4 [revised], 96 p., 1969; 1st revision, 1964.

Information in this briefly annotated catalog is grouped into: general oceanography, biology, chemistry, engineering, geology, and physics. A title index is appended. —MCM

04148 **Dahlstrom, C. D. A.** Balanced cross sections: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 743-757, illus., 1969.

Post-depositional concentric deformation produces no significant changes in rock volume. Since bed thickness remains constant in concentric deformation, the surface area of a bed and its length in a cross-sectional plane must also remain constant. Under these conditions, a simple test of the geometric validity of a cross section is to measure bed lengths at several horizons between reference lines located on the axial planes of major synclines or other areas of no interbed slip. These bed lengths must be consistent unless a discontinuity, like a decollement, intervenes. This also requires consistency of shortening, whether by folding and/or faulting, within one cross section and between adjacent cross sections. These concepts are illustrated diagramatically and by examples from the Alberta foothills. —*from* Author's abstract

03809 **Dalquest, Walter W.; Roth, Edward; Judd, Frank.** The mammal fauna of Schulze Cave, Edwards County, Texas: Florida State Mus. Bull. Biol. Sci., v. 13, no. 4, p. 205-276, illus., tables, 1969.

There are two levels of vertebrate remains in Schulze Cave: the younger material dates from about 5,000 to 3,800 B.P., the fauna is essentially modern, but the absence of the armadillo, collared peccary, ringtail, and rock squirrel is significant; the older material probably dates from 11,000 to 8,000 B.P. There are 62 species present in both levels, of which 3 are extinct, 19 are not now resident on the Edwards Plateau, and 40 still live in the area. Three species are new to Texas caves: the vagrant shrew, eastern chipmunk, and western jumping mouse. Five species from Schulze now prefer an alpine habitat. Alpine meadow conditions are postulated in the high plains during the Wisconsin. Some Schulze species are now found no closer than the woodlands of eastern Texas; hence, woodlands were continuous to the Edwards Plateau during the Wisconsin.—*from* Authors' synopsis

03845 **Dalrymple, G. B.** Ar^{40}/Ar^{36} analyses of historic lava flows: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 47-55, illus., tables, 1969.

The ratio Ar-40/Ar-36 was measured for 26 subaerial historic lava flows. Approximately one-third of the samples had Ar-40/Ar-36 ratios either higher or lower than the atmospheric value of 295.5 at the 95 percent confidence level. Excess radiogenic Ar-40 in five flows ranged from about 1×10^{13} to 1.5×10^{12} mol/g. Possible excess Ar-36 in three flows was on the order of 10^{-16} to 10^{-15} mol/g. Upper 95 percent confidence limits for excess Ar-40 in samples with normal Ar-40/Ar-36 ratios are generally less than 3×10^{-13} mol/g. The origin of the excess Ar-36 is unknown but it may be due either to the incorporation of primitive argon that has been stored in the mantle in very low potassium environments or to enrichment in Ar-36 as atmospheric argon diffuses into the rocks after they cool.—Author's abstract

Dalziel, Ian W. D. *See* Brown, Richard L. 04152

Daniell, Ellen. *See* Mangelsdorf, P. C., Jr. 03704

03678 **Dansgaard, W.; Johnsen, S. J.** A flow model and a time scale for the ice core from Camp Century, Greenland [with French and German abs.]: Jour. Glaciology, v. 8, no. 53, p. 215-223, illus., 1969.

In a flow model described for the Camp Century area in Greenland, the horizontal velocity profile along the core is assumed to be uniform from the surface down to y = 400 m above the bottom. Below this level, the horizontal velocity v_x is assumed to decrease proportionally to y. Furthermore, at a given y, v_x is assumed to be proportional to the distance x from the ice divide. The resulting vertical strain-rate under steady-state conditions gives the age of the ice as a function of y. The flow model has explained the measured temperature profile, and the time scale has been verified by comparison between observed stable isotope variations and past climatic changes (at least 70,000 yr back in time) estimated by other methods.—*from* Authors' abstract

04146 **Darling, Richard; Suffel, G. G.** Evidence for post-ore metadiabase at the Horne Mine, Noranda, Quebec: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 781, 1969.

Contacts between metadiabase dikes and massive sulfide ore in the Horne Mine exhibit patterns of dike chill and sulfide alteration that show the dikes to be younger than the sulfides. The sulfides are thus older than all intrusive igneous rocks in the mine area and an Archean volcanogenic origin for these ores seems likely. —Authors' abstract

03664 **Davies, J. L.; Tupper, W. M.; Bachinski, D. J.; Boyle, R. W.; Martin, R.** Geology and mineral deposits of the Nigadoo River-Millstream River area, Gloucester County, New Brunswick: Canada Geol. Survey Paper 67-49, 70 p., illus., tables, geol. maps, 1969.

In the northern part of the Bathurst-Newcastle mineral belt, the Nicholas Denys granitic stock and minor dikes and plugs, all Devonian, intrude Ordovician and Silurian sedimentary rocks. The latter are folded in a northeast-trending synclinorium; Ordovician rocks are in tight isoclinal folds with the same general trend. Rocks of both ages are affected by two major fault sets, trending northeast and northwest. Both Ordovician and Silurian rocks contain mineral deposits, chiefly contact metamorphic lenses in skarn (not yet exploited), and veins and sulfide lenses in sheared and melonitized zones and in northwest-striking faults and fractures. There are various suites of minerals, the Nigadoo mine being the major deposit. Disseminated molybdenite occurs in altered fracture zones of the Nicholas Denys granitic body, and in associated skarn and hornfels.—GDC

Davies, T. A. *See* Gealy, E. L. 04241

03978 **Davis, Donald Ray.** The measurement and evaluation of certain trace metal concentrations in the nearshore environment of the northwest Gulf of Mexico and Galveston Bay [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4773B-4774B, 1969.

Davis, G. L. *See* Brooks, C. 03835

Davis, J. Terrance. *See* Whitehead, Donald R. 04173

04278 **Davis, Margaret.** Palynology and environmental history during the Quaternary Period: Am. Scientist, v. 57, no. 3, p. 317-332, illus., 1969.

In southern New England, after retreat of the ice sheet, tundra changed to park-tundra and then to spruce woodland, but before the boreal forest could develop, conditions changed to favor a more temperate vegetation, the mixed coniferous-deciduous forest. Later, a temperate deciduous forest was established. With similar information from widely-distributed sites, vegetation changes over large areas can be compared, and the migration of species can be followed northward onto deglaciated terrain. With sufficient geographical coverage, it is possible to detect the influence of vegetational changes on animal populations, and assess the influence on high extinction rates of mammals, on rapid rates of morphological evolution, and on rapid development of human culture attendant upon end of the ice age. —HRC

03793 **Davitaya, F. F.** Atmospheric dust content as a factor affecting glaciation and climatic change: Assoc. Am. Geographers Annals, v. 59, no. 3, p. 552-560, illus., tables, 1969.

Solar radiation records and firn layers in glaciers indicate increasing atmospheric dust content which might significantly alter climate. In some mountain ranges, glaciers have degraded even during periods of temperature decreases. This indicates decreasing albedos with increasing dustiness of glacial surfaces.—Author's abstract

04200 **Dean, Gordon W.** A pragmatic look at the oceans' mineral resources: New York Acad. Sci. Trans., ser. 2, v. 31, no. 6, p. 731-736, table, 1969.

Potential of world oceans and submerged parts of continents is often described in overly optimistic terms, premised on vastness of the resource. Facts relating to marine-minerals extraction, with primary attention to those in relatively shallow waters are presented. Minerals recovered through drill holes (oil, gas, and sulfur) comprise the bulk of marine production. No systematic exploration has been made of deep-sea manganese nodules as a resource, but demand will be great. The continental margin mineral potential can be judged by comparing it with the onshore. Placer minerals may become exploitable off the U.S. within the next five to ten years, but potential for mining lode deposits is completely unknown. An aggressive marine minerals research program should be developed now. —ESL

Delevaux, M. E. *See* Stacey, J. S. 03837

04016 **Delfino, Joseph J.; Lee, G. Fred.** Colorimetric determination of manganese in lake waters: Environmental Sci. and Technology, v. 3, no. 8, p. 761-764, tables, 1969.

The persulfate oxidation, formaldoxime, and malachite green colorimetric methods for Mn determination were evaluated, using water samples from Lake Mendota and Cox Hollow Lake, Wis. The persulfate and formaldoxime procedures gave essentially the same results in membrane filtered samples. Turbidity in unfiltered samples resulted in the formaldoxime method giving higher results than the persulfate method. The malachite green method did not yield consistently useful data unless a lengthy modification was employed. The persulfate method proved to be the most efficient and adaptable method for analysis of Mn in lake waters.—*from* Authors' abstract

03942 **Delibrias, G.; Guillier, M. T.; Labeyrie, J.** GIF natural radiocarbon measurements III: Radiocarbon, v. 11, no. 2, p. 327-344, 1969.

A selection is listed of C-14 dates obtained from February 1966 to December 1967 on geologic samples from France, Costa Rica, Quebec, Indonesia, Cambodia, and Spitsbergen; on coral from Pacific atolls; and on cave calcareous formations in France by direct determination of biogenic carbon proportion and by dating of levels in cave stalagmites.—MCM

04335 **Dellwig, Louis Field; MacDonald, Harold C.; Kirk, J. Norman.** The potential of radar in geological exploration: Tulsa Geol. Soc. Digest, v. 36, p. 26-42, illus., reprinted 1968 [1969]; originally published 1968.

This paper was originally *in* Symposium on remote sensing of environment, 5th, Proc., p. 747-763, 1968. *See* Abstracts of North American Geology for July 1969. —MCM

04271 **DeLory, F. A.; Salvas, R. J.** Some observations on the undrained shearing strength used to analyze a failure [with French abs.], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 97-110, illus., tables, 1969.

The undrained shearing strength of the foundation soil at the site of a failure of a low embankment was investigated by several methods. It was found that both field vane and laboratory compression tests tended to underestimate the strength required for stability. Further consideration of the test specimens from sample tubes showed the undrained shearing strength varied considerably with the position of the sample in the tube. Specimens from tubes from another site yield the same type of results. The two silty clay soils involved were studied in more detail using CIU and CAU triaxial tests and comparing c_u/p' ratios. It was found that in general they yield the values usually obtained for lacustrine clays. —Authors' abstract

03831 **Demirmen, Ferruh.** Multivariate procedures and FORTRAN IV program for evaluation and improvement of classifications: Kansas Geol. Survey Computer Contr. 31, 51 p., 1969.

ITERIM is an IBM System/360 FORTRAN IV(H) program designed primarily to assess and improve classifications, although it can be used also for principal component analysis, discriminant analysis, and one-way multivariate analysis of variance. Three criteria, pooled within-in groups sum of squares, Wilks' Lambda, and the sum of the eigenvalues associated with discriminant functions, are computed to assess and compare classifications. The improvement of a classification is achieved through reduction of the pooled within-groups sum of squares in the discriminant space. The classifications compared must contain the same number of items, the same number of groups, and must be defined relative to the same number of variables. A number of options, both as to computations and output, are provided.—Author's abstract

03763 **Denson, N. M.** Distribution of nonopaque heavy minerals in Miocene and Pliocene rocks of central Wyoming and parts of adjacent states, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C25-C32, illus., tables, 1969.

Miocene and Pliocene rocks in central Wyoming and the northern High Plains of western Nebraska and northeastern Colorado contain two distinct assemblages of nonopaque heavy minerals. A plutonic assemblage, characterized by blue-green hornblende, garnet, epidote, zircon, tourmaline, actinolite, sphene, and gray-green biotite, generally constitutes more than 46 percent of the nonopaque heavy minerals in upper Miocene and Pliocene rocks, and Miocene North Park Formation. A volcanic assemblage, characterized by green-brown hornblende and oxyhornblende, augite, hypersthene, and red-brown biotite, generally constitutes 70-90 percent of the nonopaque heavy minerals in lower Miocene rocks. These heavy-mineral assemblages reliably reflect Cenozoic volcanism and tectonism and are distinct enough to correlate the formations in one area with those in another.—*from* Author's abstract

Derby, James V. *See* Naughton, John J. 03906

03918 **Dessi, K. P.; Moore, E. J.** Equivalent NaCl determination from ionic concentrations: Log Analyst, v. 10, no. 3, p. 12-21, illus., tables, 1969.

The empirical conductivity-concentration relationships of the various pure salts commonly found in formation waters are utilized in developing multipliers which will convert a given ionic concentration to an equivalent amount of NaCl. The fundamental considerations entering into development of this method are illustrated, and basic differences between it and other methods are discussed. It is readily adaptable to rapid and accurate graphical as well as computer solution. For the wide range of concentrations and compositions met by the synthetic formation water samples used in this study, the equivalent NaCl concentrations obtained by this new method did not differ, in most cases, by more than about five percent from the measured values. Comparison is made of equivalent NaCl concentrations obtained by this new method and the methods currently used when the chemical analyses are given in terms of ionic concentrations.—*from* Authors' abstract

03695 **Devore, George W.** Elastic strain and preferred orientation in monoclinic crystals: Lithos, v. 2, no. 1, p. 9-24, illus., tables, 1969.

Microcline phenocrysts in monzonite gneiss, and hornblende and actinolite crystals in a series of amphibole schists, form strong lineations of elongate crystals perpendicular to axes of small folds. Crystallographic *c* axes of the microcline and amphibole crystals form strong maxima parallel to the A fabric axis of the rocks; *b* axes of microcline form strong maxima parallel to the C fabric axes and of amphiboles form maxima parallel to B fabric axis. If folds and foliations planes are products of inelastic shear strain, these orientations correspond to maximum elastic strain energies per unit stress for these crystal and agree with prediction of preferred orientation by MacDonald (1960). A predicted effect of positive and negative shear strain was not observed. Preferred mineral orientations may be interpreted by elastic strain theory to give insight into rock deformation.—*from* Author's abstract

Dickey, Parke. *See* Rathbun, Fred C. 04317

03881 **Dickey, Parke A.** Increasing concentration of subsurface brines with depth, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 361-370, illus., 1969.

The concentration of deep subsurface brines of the chloride-calcium chemical type normally increases with depth. In many areas the increase is linear over thousands of feet vertically. The rate of increase ranges between 15,000 and 100,000 ppm/1,000 feet (50-100 mg/l/m). In the Gulf Coast this relationship reverses at great depths. Here, however, the presence of abnormal fluid pressures indicates the processes of compaction and diagenesis are not yet complete. Any hypothesis to account for the chemical composition of these brines must explain the linear nature of the increase in concentration with depth.—Author's summary

03674 **Diery, Hassan D.; McKee, Bates.** Stratigraphy of the Yakima Basalt in the type area: Northwest Sci., v. 43, no. 2, p. 47-64, illus., 1969.

Mapping in the Yakima Canyon area [central Washington] has provided the first description of approximately 2,000 feet of Yakima Basalt in the type area. The upper half of the section correlates with flows to the east named and described by Mackin (1961) and others; the lower half is described for the first time. Structural and petrographic differences between pre-Vantage and post-Vantage flows noted by others are confirmed, although some of the oldest units have features characteristic of the post-Vantage section. Distinctive structural and textural features of certain pre-Vantage members in the Yakima Canyon are aiding in the first regional correlation of this part of the section.—Authors' abstract

03800 **Dingman, Robert J.; Angino, Ernest E.** Chemical composition of selected Kansas brines as an aid to interpreting change in water chemistry with depth, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 325-339, illus., table, 1969.

The most concentrated brines are in Permian rocks; salinity decreases downward to the Ordovician rocks, at which place it increases into the Precambrian. They fit the accepted pattern of an increase in Ca, Na, and Cl with increasing salinity but they do not fit the often-predicted trend of increases in the Ca to Cl ratio, Ca content, and salinity with depth and geologic age. If many of the hypotheses concerning the chemistry of petroleum brines are valid, then the brines studied are anomalous. An alternative lies in accepting the thesis that exceptions to these hypotheses are rapidly becoming the rule and that indeed we still do not have a valid and general hypothesis to explain the origin and chemistry of petroleum brines.—*from* Authors' summary

03669 **Dionne, Jean-Claude.** Érosion glacielle littorale, estuaire du Saint-Laurent [with English and Russian abs.]: Rev. Géographie Montréal, v. 23, no. 1, p. 5-20, illus., 1969.

Shore-ice erosional scars were observed on tidal flat, mud flat, and schorre areas. Wide tidal flats of the south shore, within the upper Maritime estuary, are grooved by numerous furrows, pendicular to the shoreline, and by rimmed, shallow, circular and subcircular depressions produced by ice blocks moving forward and backward under tidal motion. Mud flats from the middle estuary are also ploughed and grooved by ice at break-up. Cellular and furrow networks characterize the slikke surface in April and May. In salt marshes, large pieces of schorre are removed and carried away by ice flows during high spring tides; shallow, subcircular and irregular basins are then produced, giving a typical microtopography to salt marshes of the St. Lawrence estuary. Many thousands of tons of sediments are removed every year by ice which, together with waves and currents, is the most important agent of sedimentation. —*from* Author's abstract

04302 **Disney, R. W.; Andress, B. O.; Chenoweth, P. A.; Schramm, M. W., Jr.** The mineral industry in Oklahoma: Tulsa Geol. Soc. Digest, v. 36, p. 89-90, 1968 [1969].

04229 **Domaschuk, L.** An analysis of porewater stress through a separation of the mean normal and deviatoric components of stress [abs.], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 223-224, 1969.

04201 **Donaldson, J. A.; Jackson, G. D.** Geology, Trout Lake, Ontario: Canada Geol. Survey Map 1200A, scale 1:253,440, text, 1969.

The most prominent feature is the moraine west of Trout Lake; abandoned beaches representing levels of Lake Agassiz flank both sides of the moraine, the highest more than 200 feet above the lake. The small outcrops are relatively evenly distributed outside the heavily drift-covered areas. Precambrian units are metavolcanic rocks, minor metasedimentary rocks, undifferentiated basic intrusions, derived schists, iron-formation, paragneiss, lit-par-lit gneiss, migmatite, granodiorite, quartz monzonite, gabbro, diorite, hornblendite, and granite. There were at least two periods of folding in the Red and Birch Lakes areas; two near-vertical regional joint sets cut all rocks. Mapped faults are marked by zones of mylonitization and rock alteration. There are five producing gold mines in the Red Lake district. —MCM

04202 **Donaldson, J. A.; Jackson, G. D.** Geology, North Spirit Lake, Ontario: Canada Geol. Survey Map 1201A, scale 1:253,440, text, 1969.

Glacial striae in the North Spirit Lake map-area record only one major glaciation. Ground moraine is thick south and east of MacDowell River; sand outwash covers much of the bedrock in the south-central part, but elsewhere outcrops are relatively abundant. Precambrian units consist of volcanic rocks, amphibolite, mafic intrusions, metasedimentary rocks, sedimentary rocks, derived schists and gneisses, iron-formation, gabbro, diorite, granodiorite, syenodiorite, quartz monzonite, and granite. Attitudes within sedimentary and volcanic belts indicate tight folding about axes generally parallel with trends of the belts. No major faults were recognized, but shearing in a wide zone may mark location of a large fault. Some mineralization is present—galena, sphalerite, pyrite, etc. —MCM

Donner, Robert L. *See* Love, Colin L. 03746

04006 **Dorman, LeRoy M.** Reply to J.-Cl. DeBremaecker's comments on "Anelasticity and the spectra of body waves" [1968]: Jour. Geophys. Research, v. 74, no. 12, p. 3304-3307, 1969.

DeBremacker (ibid., v. 73, no. 22, p. 7147, 1968) suggested that Dorman's (ibid., v. 73, no. 12, p. 3877-3883, 1968) value of Q is too high because of (1) incorrect identification of the ray path, causing improper assignment of a geometric spreading factor, or (2) nonoptimum weighting of data. It is answered that (1) Dorman's method did not require knowledge of geometric spreading and focusing, and (2) weighting is beneficial in this case as it makes the variance of the transformed observations independent of amplitude. —DBV

04025 **Dort, Wakefield, Jr.; Hogan, Austin W.; Reynolds, G. William, Jr.** Initial periodicity of new geyser, Yellowstone National Park: Jour. Geophys. Research, v. 74, no. 17, p. 4206-4208, illus., table, 1969.

A new geyser, having surface and subsurface connections with the Spectacle Pools, Yellowstone National Park, had a remarkably constant initial periodicity. Eruptive play generally occurred every 35-40 minutes and lasted 80-100 seconds. Water levels and temperatures of the associated pools exhibited consistent variations during each cycle. —Authors' abstract

Dowling, P. L. *See* Brookins, D. G. 04215

03882 **Downie, C.** Palynology of the Chuaria shales of the Grand Canyon, *in* Geology and natural history of the Grand Canyon region—Four Corners Geol. Soc., 5th Field Conf., Powell Centennial River Exped., 1969: [Durango, Colo.] Four Corners Geol. Soc., p. 121-122, 1969.

Heavy organic residues were separated from four samples from the Chuaria shales of the Grand Canyon region. A gray fissile shale from the *Chuaria* horizon yielded a lot of organic debris, including several hundred small round bodies. The bodies are flattened spheres or ellipsoids and vary in size from 12 to 62 microns; they are pale yellow gray to deep yellow brown. The forms in the Chuaria shales are similar to forms

from the Visingsö Formation recorded by Timofeyev (1960, 1966). The commonest form is one like *Trachyoligotriletes laminaritus*.—KAF

Doyle, Larry J. *See* Pilkey, Orrin H. 04062

Dunrud, C. Richard. *See* Osterwald, Frank W. 03686

04169 **Durrani, S. A.; Christodoulides, C.** Allende meteorite—Age determination by thermoluminescence: Nature, v. 223, no. 5212, p. 1219-1221, illus., 1969.

The upper limit for the age of the Allende meteorite, which fell in Mexico on 8 February 1969, is determined by the thermoluminescence dating method as 14.3 ± 7.3 m.y.—DBV

03789 **Dury, George H.** Perspectives on geomorphic processes: Assoc. Am. Geographers Comm. College Geography Resource Paper 3, 56 p., illus., tables, 1969.

This series of experimental documents for use of both student and instructor is designed to supplement existing texts and to fill a gap between significant research and readily accessible materials. The general aim of this paper is to review developments in geomorphology, to indicate its present character and status, to demonstrate its increasingly close linkages with other types of study, and to suggest future developments. Headings of the parts are: aims and methods of classical geomorphology, extensions and challenges, landform evolution and climatic changes, the quantitative revolution, applied geomorphology, and summary. Constraints of space have limited discussion of geomorphology of dry lands, and glacial, periglacial, and coastal morphology or their relations to fluvial work.—MCM

Dwornik, Edward J. *See* Faust, George T. 03702

03952 **Dymond, Jack.** Age determinations of deep-sea sediments—A comparison of three methods: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 9-14, illus., tables, 1969.

Potassium-argon ages determined on glass shards from deep-sea volcanic ash layers are compared with paleomagnetic and Th-230/Th-232 age determinations. In three cores K-Ar ages agree satisfactorily with ages inferred from paleomagnetic studies. Ages on eight ash layers in a fourth core, however, are significantly older than the paleomagnetic ages. In the same core Th-230/Th-232 measurements indicate a sedimentation rate slower than that given by the paleomagnetic results but approximately in agreement with the rate given by the K-Ar results. One possible explanation for the discrepancies in this core is that the direction of remanent magnetism was not permanent at the sediment-water interface but was "locked-in" at a depth of approximately 1-1/3 meters.—Author's abstract

04329 **Dyni, John R.** Structure of the Green River Formation, northern part of the Piceance Creek basin, Colorado: Mtn. Geologist, v. 6, no. 2, p. 57-66, illus., 1969.

Subsurface data in northern Piceance Creek basin show well-defined folds trending W-NW. These are delineated by structure contours on the orange marker in lower part of the Green River Formation. Some, such as Red Wash syncline and Rangely anticline, extend at the surface in older rocks for many miles west of the basin; others, such as Sulphur Creek anticlinal nose and Hunter Creek syncline, seem limited to the basin. The basin structure is not strongly reflected in exposed youngest rocks of the Green River Formation. Their structure may have been altered by collapse following ground-water dissolution of minerals at depth. An isopach map of an interval of rocks containing most of the Green River oil-shale deposits suggests basin folds were formed during the time of their deposition; a few, including Piceance Creek dome and Hunter Creek syncline, were modified by later folding. —*from* Author's abstract

03722 **Eaton, Gordon P.** Aeromagnetic interpretation, *in* Mineral resources of the Blue Range primitive area, Greenlee County, Arizona, and Catron County, New Mexico: U.S. Geol. Survey Bull. 1261-E, p. E29-E31, 1969.

Magnetic contours, superposed on the geologic map of the Blue Range primitive area, indicate three different magnetic patterns: (1) northwestern third where anomalies of high amplitude and short wavelength occur in an area underlain by flows and flow breccias of basaltic andesite; (2) central part, characterized by a broad, irregular, troughlike, magnetic low, and for the most part underlain by pyroxene-hornblende andesites and Gila Conglomerate; and (3) a magnetic high with an amplitude of at least 80 gammas two miles south of Brigham Peak, an anomaly which could have economic significance.—MCM

Eberhardt, P. *See* Eugster, O. 04057

03949 **Ehrlinger, H. P., 3d; tenKate, W. G.; Jackman, H. W.** Kankakee dune sands as a commercial source of feldspar: Illinois Geol. Survey Indus. Minerals Note 38, 17 p., illus., tables, 1969.

Illinois has exceedingly large deposits of low-grade feldspar sands, a potential source of the mineral feldspar. As there is no commercial production of feldspar in Illinois at present, considerable tonnages of it are being shipped into the state for industrial use. This publication is the first of a series describing Illinois feldspar deposits and describing the technology conducted in our laboratories to produce commercial feldspar concentrates. It deals specifically with the sands in the Kankakee River area in northwestern Illinois. Tests indicate that commercial-grade feldspar concentrates can be made from these sands.—Authors' abstract

03973 **El-Nahal, Mohamed Abdelmonem M. H.** Chemical behavior of a zeolitic sodic soil and its response to laboratory treatments [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4473B-4474B, 1969.

03839 **Elson, John A.** Radiocarbon dates, *Mya arenaria* phase of the Champlain Sea: Canadian Jour. Earth Sci., v. 6, no. 3, p. 367-372, table, 1969.

The history of the Champlain Sea is divided into an early cold period of subarctic water, the *Hiatella* phase, that lasted from about 11,800 yr ago until a low water phase about 10,800 yr ago. This was followed by an interval of warmer boreal water, the *Mya arenaria* phase, that lasted from about 10,800 yr ago until 10,200 yr ago or the end of the Champlain Sea. General descriptions, previously unpublished, of Groningen dates GrN 2031 (10,870±100 B.P.), GrN2032 (10,450±80 B.P.), GrN 2,034 (10,590±100 B.P.), and GrN 2,035 (10,330±100 B.P.) are presented. These dates record the *Mya arenaria* phase of the Champlain Sea, which may have had an initial rising (transgressive) phase, although stratigraphic evidence, supported by radiocarbon dates, is not wholly conclusive.—*from* Author's abstract

04122 **Emiliani, Cesare.** A new paleontology: Micropaleontology, v. 15, no. 3, p. 265-300, illus., 1969.

Current paleontological research is handicapped by nomenclatorial formalism, the definition of species, and the practice of holotype designation. Species is redefined as a platonic idea based on a representative sample of mature phenotypes. Accurate study of such samples yields a large amount of genetic and environmental information. This method, here applied to mature shells of planktonic foraminifera from Pleistocene deep-sea cores, leads to stratigraphic zonations some two orders of magnitude more accurate than presently possible, and appears invaluable also for ecological and paleoecological studies. —Author's abstract

Engel, Celeste G. *See* Luykendyk, Bruce P. 04104

04060 **Enos, Paul.** Anatomy of a flysch: Jour. Sed. Petrology, v. 39, no. 2, p. 680-723, illus., tables, 1969.

Excellent exposures of the Middle Ordovician Cloridorme Formation in the northern Gaspé permit correlation up to 7.5 km and well-defined units up to 10.5 km in the direction of current flow. Flutes and grooves are the most abundant directional structures, the groove orientation being more variable than that of the flutes. The variability of direction indicators is greater in graywacke, and greater vertically than

horizontally in the same bed. Few longitudinal trends were detected, but locally eroded fragments of finer-grained sediments are important as textural elements, as tools, and as erosional indicators. Individual graywacke and calcisiltite beds are very discontinuous in longitudinal section. A volume of 10 to 30 × 10^6 m^3 is estimated for an average graywacke bed. —*from* Author's abstract

Epstein, S. *See* Hoefs, J. 03696

03872 **Erdosh, George.** Rock cataloguing made easy with keysort cards: Canadian Jour. Earth Sci., v. 6, no. 3, p. 503-509, illus., 1969.

Systematic cataloging of rocks is essential for both teaching and research. A simple cataloging system is proposed using hand-sorted punch cards that should be satisfactory for collections containing items up to a few tens of thousands. In addition to punching, the cards as well as the specimens are filed according to a certain system in order to facilitate the quick finding and refiling of any number of specimens. —Author's abstract

Estes, Ernest. *See* Pilkey, Orrin H. 04062

04057 **Eugster, O.; Eberhardt, P.; Geiss, J.** Isotopic analyses of krypton and xenon in fourteen stone meteorites: Jour. Geophys. Research, v. 74, no. 15, p. 3874-3896, illus., tables, 1969.

Concentrations and isotopic compositions of Kr and Xe in 12 chondrites and 2 achondrites have been determined. Concentrations of spallation-produced Kr and Xe correlate with concentrations of the spallation-produced light rare gases. Variations in the Kr spallation spectrum are caused by differences in hardness of the energy spectrum, which are also responsible for variations in the spallation ratio Ne-21/He-3 in ordinary chondrites. Neutron slowing down densities and minimal preatmospheric radii and masses are calculated for some of the investigated chondrites. For the chondrites and for a Ca-poor achondrite, Kr-81 ages agree with the ages calculated from the He-3 concentrations. A correlation between concentrations of Br and trapped components in Kr- and Xe-rich ordinary chondrites agrees with those known for carbonaceous chondrites. —*from* Authors' abstract

04058 **Eugster, O.; Tera, F.; Wasserburg, G. J.** Isotopic analyses of barium in meteorites and in terrestrial samples: Jour. Geophys. Research, v. 74, no. 15, p. 3897-3908, illus., tables, 1969.

Isotopic composition and concentration of barium in 6 stone meteorites and the silicate inclusions of 2 iron meteorites and 3 terrestrial samples were measured by use of a "double spike" isotopic dilution technique in order to correct for laboratory fractionation. Any differences between the abundances of the isotopes in meteoritic and terrestrial Ba were found to be less than 0.1 percent for all isotopes. The percent abundances of Ba found for Ba-138, Ba-137, Ba-136, Ba-135, Ba-134, Ba-132, and Ba-130 are 71.699, 11.232, 7.853, 6.592, 2.417, 0.1012, and 0.1058, respectively. Because of the higher precision, these abundances should replace the currently accepted values. These results show the variations in the Ba isotopes reported by S. Umemoto (1962) to be unsubstantiated. —Authors' abstract

04066 **Evamy, B. D.** The precipitational environment and correlation of some calcite cements deduced from artificial staining: Jour. Sed. Petrology, v. 39, no. 2, p. 787-793, illus., 1969.

In carbonate provinces ferrous iron is stable only under reducing conditions; it will, therefore, not enter cements precipitated in the oxidizing zone above the water table. Once in the calcite lattice, however, ferrous iron can normally survive subsequent passages through oxidizing media. The ferroan character of a cement is thus good and lasting evidence for its precipitation under reducing conditions. In this latter environment, however, reducing conditions are only established in the presence of organic matter, the absence of which could result in local oxidizing conditions and thus in the formation of ferrous-iron-free cements. The latter are therefore not necessarily

indicative of precipitation above the water table. Certain carbonate cements exhibit variations in the ferrous iron content, and represent diagenetic time lines.—*from* Author's abstract

04194 **Evans, E. L.** The role of the Geological Association of Canada: Geol. Assoc. Canada Proc., v. 20, p. 1-3, 1969.

The original seven aims of the Geological Association are reviewed and it is noted that two of these are no closer to fulfillment than when the Association started in 1947—establishing a permanent headquarters and a central reference library. Ways of improving finances to build a headquarters are reviewed. The membership as of March 1968 was 1,083 and should increase rapidly if it is made sufficiently attractive; more services to the members will require greater participation by the entire membership. Establishment of regional groups, or of groups tied to disciplines has been suggested. Formation of a super-organization, The Canadian Union of Geoscience, is suggested, membership to be by society. —ESL

04054 **Evernden, J. F.** Identification of earthquakes and explosions by use of teleseismic data: Jour. Geophys. Research, v. 74, no. 15, p. 3828-3856, illus., tables, 1969.

Criteria for achieving an order of magnitude discrimination between underground explosions and shallow-focus continental earthquakes are presented. The basis of all these criteria is the gross difference between earthquakes and explosions as regards their relative generation of short- and long-period waves. It is also shown that depth of focus of small events can be accurately determined either by use of master-controlled traveltime corrections or by determination of time of origin (Pg, S-P, etc.). Therefore, the basic problem for differentiating earthquakes and underground explosions of magnitude 4.75 or greater by seismic criteria has been solved. The remaining problems are the detection of long-period waves at low signal-to-noise ratios and the evaluation of the applicability of long-period identification criteria for low-magnitude events. —Author's abstract

04261 **Eyring, H.; Christensen, C. J.; Johnston, H. S.** (editors). Annual review of physical chemistry, V. 20: Palo Alto, Calif., Annual Reviews, Inc., 520 p., illus., tables, 1969.

The subject matter is divided into 16 sections, one of which (Arnold, J. R.) is cited separately. The number of active research areas in physical chemistry grows so rapidly that areas once treated annually, must now alternate with fields like Mossbauer effect, NMR, ESR. The introductory chapter dealing with the beginnings of physical chemistry in various parts of the world has been added. —ESL

Fahey, Joseph. *See* Faust, George T. 03702

Fahlquist, Davis A. *See* Bunce, Elizabeth T. 03920

04162 **Fahrig, W. F.; Jones, D. L.** Paleomagnetic evidence for the extent of Mackenzie igneous events: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 679-688, illus., tables, 1969.

Published paleomagnetic data on north-northwesterly striking diabase dikes of Helikian age in the western part of the district, on the Muskox Intrusion, on the Coppermine River volcanics, and on the Sudbury dikes suggest that they are all products of closely related igneous events. Data suggest that diabase sheets in the East Arm of Great Slave Lake and of dikes as far to the northeast as Melville Peninsula and as far south as Manitoba are also parts of these events. Radioactive ages suggest an age of about 1200 m.y. for the formation of these rocks. The name Mackenzie igneous events is proposed for all of these apparently related intrusive and extrusive igneous episodes. —*from* Authors' abstract

Fairbairn, H. W. *See* Brookins, D. G. 03858

03871 **Fairbairn, H. W.; Hurley, P. M.; Card, K. D.; Knight, C. J.** Correlation of radiometric ages of Nipissing diabase and Huronian metasediments with Proterozoic

orogenic events in Ontario: Canadian Jour. Earth Sci., v. 6, no. 3, p. 489-497, illus., tables, 1969.

Whole rock Rb-Sr age dates (1) confirm the age of the diabase in a single sill at Gowganda (2162 ± 27 m.y.) and (2) show the age of the Gowganda Formation (which the sill intruded) to be 2288 ± 87 m.y. In marked contrast metasediments and metavolcanics in the Huronian section southwest of Sudbury show younger ages ranging between 1800 and 2200 m.y. This is interpreted in terms of known orogenic disturbance of the Huronian rocks south and west of Sudbury and its absence in the Cobalt-Gowganda area to the northeast. Both minerals and whole rocks have responded by showing low discordant ages in the disturbed area. The higher and accordant ages in the undisturbed environment agree with the geologic succession and are believed to be the true ages of the rocks.—*from* Authors' abstract

04223 **Fairley, William M.** Stratigraphy and structure of the Murphy Marble Belt in parts of northern Georgia, *in* Precambrian-Paleozoic Appalachian problems: Georgia Geol. Survey Bull. 80, p. 89-120, illus., tables, 1969.

The Murphy Marble Belt is a sequence of metamorphosed sedimentary rocks whose oldest unit is the Nantahala Formation overlain in turn by the Brasstown, Murphy, Marble Hill schist, and Andrews Formations. This paper presents data on the mineralogy and stratigraphy of the Belt, especially in the vicinity of Tate and Marble Hill, Georgia. Facies terminology adopted here is discussed. Facies changes near Tate, various aspects of the lithologies in Marble Valley, east-west variations in mineralogy and texture, and the Marble Belt near Whitestone, Ga., are examined. Modal and chemical analyses are included. —VSN

03813 **Farrand, William R.; Zahner, Robert; Benninghoff, William S.** Cary-Port Huron interstade—Evidence from a buried bryophyte bed, Cheboygan County, Michigan, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 249-262, illus., 1969.

A thin layer of mosses between two thick layers of sandy-clay till is 12,500 to 13,000 yr old. These dates and pollen of a locally treeless flora form the basis for correlation with the Cary-Port Huron interstade of Wisconsin glaciation. The absence of a Two Creeks horizon and presence of a single unit of till showing no evidence of an erosional break between Cary-Port Huron time and Glacial Lake Algonquin time are interpreted as evidence that the Straits of Mackinac was not deglaciated during Two Creeks time. According to this interpretation, the Petoskey-Cheboygan lowland drained the low-level Two Creeks lake from Lake Michigan to Lake Huron.—*from* Authors' abstract

04085 **Faulkner, E. L.** Genetic implications of cobalt and nickel distribution in sulphide deposits of the Coronation mine, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 155-180, illus., tables, 1969.

The many sulfide deposits in the Flin Flon area may be divided on the basis of quantitative mineralogy into a larger "barren" group consisting of pyrite and/or pyrrhotite with nominal amounts of other base-metal sulfides, and a smaller "economic" group consisting of pyrite and/or pyrrhotite with relatively large amounts of other base-metal sulfides, notably chalcopyrite and sphalerite. [A table summarizes results]. The contrasting Co/Ni ratios of the two groups strongly suggest that they are not genetically related. The barren deposits were probably formed by reaction of a sulfur-bearing hydrothermal phase from an adjacent granodiorite, and the metals of the economic deposits were probably concentrated as chloro-complexes. —*from* Author's abstract

03702 **Faust, George T.; Fahey, Joseph; Mason, Brian; Dwornik, Edward J.** Pecoraite, $Ni_6Si_4O_{10}(OH)_8$, nickel analog of clinochrysotile, formed in the Wolf Creek meteorite: Science, v. 165, no. 3888, p. 59-60, illus., table, 1969.

Pecoraite is a new phase in the natural system H_2O-NiO-MgO-SiO_2, the nickel analog of clinochrysotile. It occurs in cracks in the Wolf Creek meteorite in Australia where it was formed under hydrothermal conditions. Particles of pecoraite are very small curved plates which have begun to coil; some have achieved spiral form.—Authors' abstract

04024 **Favreau, R. F.** Generation of strain waves in rock by an explosion in a spherical cavity: Jour. Geophys. Research, v. 74, no. 17, p. 4267-4280, illus., 1969.

A mathematical solution to predict the properties of the strain waves generated when an explosive detonates inside a spherical cavity in an infinite medium is presented. In the case of commercial explosives in rock, the strain pulse is a highly damped oscillating wave train the characteristics of which depend on the properties of the rock (its density, Young's modulus, and Poisson's ratio), on the radius of the cavity, and on the properties of the explosive (its explosion pressure P and the ratio of the specific heats of its explosion gases). The theory is compared with some experimental data; the agreement is fair, if account is taken of charge shape and detonation time effects. Applicability of the theory to prediction of the relative blasting effectiveness of different explosives is briefly discussed. —Author's abstract

04064 **Felix, David W.** An inexpensive recording settling tube for analysis of sands: Jour. Sed. Petrology, v. 39, no. 2, p. 777-780, illus., table, 1969.

An automatically recording settling tube for rapid size analysis of sand can be constructed from Plexiglass tubing, a transducing cell, and a small chart recorder for less than 1100 dollars (1968 prices). It eliminates time consuming processes associated with sieving, and yields data in terms of hydraulic equivalent size. Reproducibility of the arithmetic mean averages to $\pm$ 0.9 percent for several replicate samples. This compares with $\pm$ 1 percent for sieves, and $\pm$ 5 percent for the Emery tube. —Author's abstract

Ferris, C. S. *See* Arnold, R. G. 04087

04168 **Fertl, Walter; Jessen, F. W.** Cation replacement studies on heteroionic bentonitic clay fractions using specific ion glass electrodes [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 17, no. 1, p. 1-8, illus., tables, 1969.

Centrifuged fractions, ranging in size from 2.0 to 0.5μ of a Wyoming bentonite, Bentonita de Durango from Mexico, and Helms clay from Texas were studied. The variation in replacement of Na^{+0}, Ca^{2+}, Mg^{2+}, K^{+}, and H^{+} from these heteroionic clay systems under specific equilibrium conditions of salt concentrations was measured. The displacement cation distribution was monitored by using specific ion glass electrodes, such as a sodium ion electrode, a cationic glass electrode, a calcium ion electrode and a Tektite electrode. Some factors affecting the exchange reactions are discussed and application of findings to drilling and production techniques is indicated. —Authors' abstract

04294 **Fetzner, Richard W.** Athabasca oil sand evaluation using geological data processing methods [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 95, 1968 [1969].

Fidler, Richard E. *See* Norris, Stanley E. 03710

03936 **Field, William O.** Current observations on three surges in Glacier Bay, Alaska, 1965-1968, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 831-839, illus., 1969.

Nine glaciers in Glacier Bay, in southeastern Alaska, and three others within a radius of 60 km have been known to surge in the last 60 years. Of these, seven have surged during the 1960's. The surges of three of them, the Tyeen, Rendu, and Carroll, are discussed in this paper. Each glacier has surged one or more times previously. The course of each surge has been documented by photography but there has been no study of the regimes of these glaciers. The distribution in time and space of these and other surges in the Glacier Bay area are discussed and it is suggested that there may

be external factors which cause more surges during some periods than others. These relationships need to be correlated and analyzed. A program of future observations is suggested.—Author's abstract

Field, William O. *See* Horvath, Eva V. 03938

03840 **Findlay, D. C.** Origin of the Tulameen ultramafic-gabbro complex, southern British Columbia: Canadian Jour. Earth Sci., v. 6, no. 3, p. 399-425, illus., tables, 1969.

The complex intruded the Upper Triassic metavolcanic and metasedimentary rocks of the Nicola Group, and on the basis of geologic relations and K-Ar age determinations, is tentatively dated as Late Triassic. The elongate stratiform body has irregular internal structure best explained by deformation contemporaneous with crystallization. The rocks are from the fractional crystallization of an ultrabasic magma. A gabbroic mass partly borders and partly overlies the ultramafics. The gabbro and ultramafic bodies came from different magmas but are similar enough to suggest an ultimate petrogenic affinity. Comparison with the nearby Copper Mountain stock suggests that all are part of a regional suite of alkalic intrusions. These may be comagmatic with the Nicola volcanics.—*from* Author's abstract

04034 **Fisher, D. E.** Reply [to comments by G. W. Wetherill on "Frequency distribution of meteorite-Earth collisions" (1968)]: Jour. Geophys. Research, v. 74, no. 17, p. 4406, 1969.

Contrary to Wetherill's comment (ibid., p. 4402-4405) the expectation that "no noise" meteorites would be accompanied by less spectacular atmospheric phenomena is borne out by a closer investigation of the literature. These meteorites accompanied by less spectacular phenomena are mainly afternoon falls and thus more likely to be indicative of social than of astronomical effects. UFO's show an identical anistropy; this may be coincidental, but it seems more reasonable that there is a common social effect. —DBV

Fisher, David E. *See* Boström, Kurt. 03899

Fisher, David E. *See* Boström, Kurt. 03970

04056 **Fisher, David E.; Joensuu, O.; Boström, Kurt.** Elemental abundances in ultramafic rock and their relation to the upper mantle: Jour. Geophys. Research, v. 74, no. 15, p. 3865-3873, illus., tables, 1969.

Neutron activation and spectrographic data on 58 ultramafic rocks, representative of diverse geographic and geologic settings, indicate considerable differences in abundances of Al, Si, Ti, Co, Cr, Fe, Sc, Mn, Cu, V, and Ni. These wide differences in composition vitiate any calculation of mean elemental abundances for ultramafic rocks taken as a single homogeneous group and indicate gross chemical differentiations either within the mantle or between the mantle and the ultramafic rocks. —Authors' abstract

03792 **Fitch, John E.** Fossil lanternfish otoliths of California, with notes on fossil Myctophidae of North America: Los Angeles County Mus. Contr. Sci., no. 173, 20 p., illus., tables, 1969.

Otoliths (sagittae) from 20 species of lanternfishes (Myctophidae) are known from the North American Cenozoic: 15 from Plio-Pleistocene (California) 13 from Miocene (7 California; 5 Veracruz, Mexico; 1 Jamaica), and 2 from Eocene (California). The high incidence of species from California deposits appears to be a reflection of the proximity of the shoreline to myctophid habitat (deep water), rather than a more abundant fauna, but both factors could be involved. In addition to the 30 species known from their otoliths, skeletal remains (imprints) of seven kinds of lanternfishes have been found in Miocene diatomites of southern California. Otoliths in some of these imprints make it possible to compare them with fossil myctophid saggitae that are unaccompanied by skeletal remains.—Author's abstract

Flach, K. W. *See* Nettleton, W. D. 04287

Flach, K. W. *See* Nettleton, W. D. 04322

03968 **Fleischer, Michael; Altschuler, Z. S.** The relationship of the rare-earth composition of minerals to geological environment: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 725-732, illus., tables, 1969.

The effect of geological environment on the composition of lanthanides in minerals is illustrated by data on monazite, sphene and apatite. In general, igneous rocks rich in silica are favorable for the concentration of the heavy lanthanides and yttrium; those low in silica and high in carbonate are favorable for the concentration of the light lanthanides. The effects of geological environment are greater for minerals such as sphene and apatite, in which lanthanides are minor constituents, than they are for minerals such as monazite, in which lanthanides are major constituents. Apatite of marine sedimentary origin (a large potential source of rare earths) shows marked depletion of cerium.—KAF

Foss, J. E. *See* Kline, J. R. 04286

04234 **Foster, Margaret D.** Studies of celadonite and glauconite: U.S. Geol. Survey Prof. Paper 614-F, p. F1-F17, illus., tables, 1969.

A comparative study of analyses of 10 celadonites and 19 glauconites having more than 0.65 ion of K per half cell indicates that these minerals belong to an isomorphous replacement series that starts with a theoretical dioctahedral tetrasilicic iron mica end-member and that is characterized by simultaneous replacement of Si and R^{+2} (VI) and Al (IV) and R^{+3} (VI). The relation between Si and R^{+2}(VI), between Al (IV) and R^{+3} (VI), and deficiencies in layer charge suggests that some glauconites have undergone oxidation. Glauconitization is interpreted as made up of two separate, unrelated processes, incorporation of Fe into the structure, and fixation of K in interlayer positions. The specific environment of development of a glauconite is a greater factor in determining composition than its geologic age. —MDF

03961 **Fox, P. E.** Petrology of Adamant pluton, British Columbia: Canada Geol. Survey Paper 67-61, 101 p., illus., tables, geol. maps, 1969.

Surrounded by amphibolite metamorphic rocks of the Proterozoic Horsethief Creek Group, this elongate, east-trending pluton is a composite of a hypersthene-augite core and enclosing hornblende quartz monzonite, with progressive recrystallization through an isochemical transition zone. Internal structural patterns follow two fold system of the northern Selkirk Mts.; marginal foliation is locally associated with migmatite zones. Plagioclase foliation and poor lineation in the core are obliterated and truncated by younger hornblende and biotite foliation in the peripheral body. Augite and hypersthene show a constant Fe-Mg ratio; that for coexisting hornblende and biotite is variable due to a thermal gradient from the pluton core to margin. The pluton, originally emplaced as pyroxene monzonite, underwent metamorphism and reintrusion during late Mesozoic.—GDC

Francis, T. J. G. *See* Raitt, R. W. 03921

04042 **Franks, Paul C.** Synaeresis features and genesis of siderite concretions, Kiowa Formation (Early Cretaceous), north-central Kansas: Jour. Sed. Petrology, v. 39, no. 2, p. 799-803, illus., 1969.

The Kiowa Formation (Early Cretaceous) of north-central Kansas contains abundant discoidal concretionary masses of impure siderite (so-called clay-ironstone) that display features similar to the synaeresis cracks developed in argillaceous sediments. These features are in keeping with an early diagenetic origin of the siderite concretions and are suggestive of the dewatering of colloidally precipitated iron carbonate soon after deposition of the enclosing muds. The iron in the siderite concretions probably was released from coatings of iron oxide or hydrated ferric oxide on the detrital clay micelles that make up illitic Kiowa shale. —Author's abstract

04251 **Fraser, D. J.** Zama member controls oil gas occurrence: Oilweek, v. 20, no. 8, p. 12-13, illus., 1969.

The Zama-Virgo area in northwestern Alberta includes a swarm of Middle Devonian Keg River reefs, many of which contain one-half to three million barrels of oil. Evaporite deposition preceded and followed deposition of the Zama Member. The structural closure of this member over the Keg River reef pinnacles controls hydrocarbon migration and the thickness of pay. The main migration path is probably through the Zama, and the mechanism is differential entrapment. Wells might not be drilled on the reef crest, and would be dual Zama and Keg River producers. Gas has also been encountered in the downdip traps, with the Zama as the migration path. —ESL

03663 **Frebold, Hans; Tipper, H. W.; Coates, J. A.** Toarcian and Bajocian rocks and guide ammonites from southwestern British Columbia: Canada Geol. Survey Paper 67-10, 55 p., illus., 1969.

Toarcian and Bajocian [Early and Middle Jurassic] guide ammonites, most of which are not previously known in southwestern British Columbia are described in relation to the stratigraphy of the beds concerned in Manning Park, Taseko Lakes and Nechako River areas.—Authors' abstract

03893 **Frebold, Hans; Tipper, H. W.** Lower Jurassic rocks and fauna near Ashcroft, British Columbia and their relation to some granitic plutons: Canada Geol. Survey Paper 69-23, 20 p., illus., 1969.

The oldest fossiliferous Jurassic rocks near Ashcroft, British Columbia, contain the pelecypod genus *Weyla* J. Bohm. This genus is known to be restricted to the Lower Jurassic and the age of the rocks is accordingly not Middle Bajocian, to which they had been assigned previously, but Early Jurassic. Detailed age determination is difficult but Sinimurian is considered probable. The underlying conglomeratic beds resting unconformably on the Upper Triassic Nicola Group are believed to be Hettangian in age. The Guichon Batholith, which supplied detritus to these conglomerates is believed to be Rhaetian in age, dated isotopically at 200 million years.—Authors' abstract

04186 **Frebold, Hans.** Subdivision and facies of Lower Jurassic rocks in the southern Canadian Rocky Mountains and foothills [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 76-90, illus., table, 1969.

New faunas found at some localities in the Lower Jurassic beds show the presence of more ammonite zones and substages than previously known. This account of new findings plus known data results in more detailed understanding. Sinemurian and Toarcian beds and faunas are described. In spite of these discoveries in the lower Fernie Group, the opinion that there are gaps in the sequence is still valid. A cross section showing subdivision and facies of the Lower Jurassic in the southern Rocky Mts. and foothills is included.—ESL

Freeth, S. J. *See* Burke, Kevin. 04041

Friedman, Gerald M. *See* Johnson, Kenneth G. 04035

Friedman, Irving. *See* Hall, Wayne E. 03830

04299 **Frink, C. R.** Fractionation of phosphorus in lake sediments—Analytical evaluation: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 326-328, 1969.

Methods for the fractionation of P in soils were evaluated in the fractionation of P in lake sediments. Current methods for Al-P and Fe-P were adequate, but modifications were required in the determination of reductant-soluble and Ca-P. Organic P obtained by difference between total P and the sum of the inorganic P fractions was more closely related to the organic matter content of the sediments than was organic P determined by conventional methods. —Editor's brief

04089 **Froese, E.** Metamorphic rocks from the Coronation mine and surrounding area, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 55-77, illus., tables, 1969.

The sulfide ores are developed in cordierite-anthophyllite rocks as well as basic volcanic rocks. Gangue assemblages are compatible in metamorphic grade with the surrounding area, the staurolite-almandine subfacies of the almandine-amphibolite facies. A preferential development of phyrrhotite in cordierite-anthophyllite rocks and pyrite in basic volcanics is considered evidence of the reaction between silicates and sulfides at metamorphic conditions. Gahnite also indicates reactions between sphalerite and aluminous silicates. The cordierite-anthophyllite rocks represent original zones of chloritization developed at the time of mineralization, rather than products of high-temperature metasomatism. The chloritic alteration zones and the sulfide mineralization, as well as the enclosing volcanic host rocks, have been subjected to regional metamorphism. —*from* Author's abstract

04093 **Froese, E.** General geology of the Coronation mine area, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 7-35, illus., tables, 1969.

The Precambrian rocks are predominantly volcanic rocks of the Amisk Group and clastic sedimentary rocks of the Missi Group, forming a sequence which has been metamorphosed to the Kisseynew Complex; basic intrusions are associated with the Amisk. All these rocks were subjected to deformation and regional metamorphism accompanied by granodioritic intrusions. The granodiorite and earlier rocks are cut by wrench faults and shear joints. The Coronation mine area, a small part of the Flin Flon region, is underlain by rocks of the Amisk Group, basic intrusions, and granodioritic masses. Volcanic rocks contain some sulfide mineralization, including orebodies of the Coronation, Birch Lake, and Flexar mines. —*from* Author's abstract

04198 **Frye, John C.** Environmental Geology: Prof. Geologist, v. 6, no. 3, p. 6-7, 1969.

Environmental Geology is really a state of mind that attunes the thinking of a geologist to the problems of adapting our exploding human population to a finite Earth. The thing required to create this state of mind is self preservation of *homo sapiens* or of geology as a profession. Because all environmental factors are based on the Earth, geologists should be the ones to attack the problems. The first lesson they should learn is communication in language the common man can understand. The applications of Environmental Geology are placed in four groupings: terrain analysis, hydrogeology and water supply data, waste disposal, and mineral resource data. This speech may also be considered a plea for the return of the "generalist." —ESL

Fujita, T. *See* Fukunaga, O. 03688

03688 **Fukunaga, O.; Takahashi, K.; Fujita, T.; Yoshimoto, J.** Phase equilibrium between MnO_2 and Mn_2O_3: Materials Research Bull., v. 4, no. 5, p. 315-322, tables, 1969.

The equilibrium relation between MnO_2 and Mn_2O_3 has been studied in the temperature interval 800 to 1200°C at pressures ranging from 3 to 30 kb. The univariant equilibrium curve for the coexistence of MnO_2 and Mn_2O_3 is described by log P = 6.97 - 3740/T (atm-°K).—Authors' abstract

04141 **Fulton, R. J.; Pullen, M. J. L. T.** Sedimentation in Upper Arrow Lake, British Columbia: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 785-791, illus., 1969.

Two rivers, the Columbia and the Incomappleux, empty into the north end of Upper Arrow Lake. The form and the general pattern of sedimentation of the two river deltas were determined by an echo sounder survey. The three classical delta sedimentation zones were recognized and observations made on sedimentation in each. Sedimentation in the topset zone is largely channel and overbank deposition similar to that taking place on river floodplains. The bottomset zone receives fine silt and clay carried out to where it can settle under lacustrine conditions. The bulk of the sediment is deposited at the river mouths near the top of the foreset zone. Following initial deposition, the sand and silt dumped at the river mouths is carried into the lake basin by a slow sliding failure of the entire foreset zone. —Authors' abstract

Fulton, Robert B., 3d. *See* Rittenhouse, Gordon. 03843

04222 **Furcron, A. S.** Late Precambrian and early Paleozoic erosional and depositional sequences of northern and central Virginia, *in* Precambrian-Paleozoic Appalachian problems: Georgia Geol. Survey Bull. 80, p. 57-88, illus., tables, 1969.

Precambrian igneous rocks, exposed in the Blue Ridge and Piedmont of northern and central Virginia, are unconformably overlain by the Late Precambrian Lynchburg Group. The Lynchburg was folded and metamorphosed in Late Precambrian and, in the central and western parts, was largely removed by erosion to expose the earlier igneous complex. Following this, the Swift Run pyroclastics were deposited. The Blue Ridge was a positive area in Lower Cambrian and from Triassic to Holocene. On its eastern slope, Catoctin flows initiated an early Paleozoic eugeosyncline which received sediments from land far to the east; sediments and volcanics were folded and overthrust at times during the Paleozoic. The Blue Ridge was again uplifted and faulted along its eastern side in Triassic. [Three K-Ar ages reported for Lynchburg gneisses range from 425-345 m.y.]. —*from* Author's abstract

03972 **Fuse, Kiyono; Anders, Edward.** Aluminum-26 in meteorites—[Pt.] 6, Achondrites: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 653-670, illus., tables, 1969.

Cosmogenic Al-26 was measured by nondestructive γ-γ coincidence counting in 21 achondrites. A weighted regression analysis of these and earlier data gave the following mean production rates of Al-26, in dpm per kg of target element: Al, 476 ± 54; Si, 310 ± 10; S, 38 ± 44. A review of Al-26 data for chondrites shows that those determined by nondestructive γ-γ coincidence counting show little dispersion. The eucrite Serra de Magé has an Al-26 age of 0.065 ± 0.018 m.y., very much shorter than its He-3, Ne-21, Ar-38 age of 1.9 m.y. Apparently it has suffered a two-stage radiation; first for > 32 m.y. shielded by 1.5-5 m of overlying material, and then for < 0.10 m.y. as an unshielded, decimeter-sized fragment. A similar history is indicated for the Cl chondrite Ivuna. —*from* Authors' abstract

04238 **Fyles, James T.** Evolution of the Slocan syncline in south-central British Columbia —Discussion [of paper by J. V. Ross and P. Kellerhals, 1968]: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 802-806, 1969.

The conclusion of Ross and Kellerhals that rocks of the Slocan Group were deposited in a phase 2 syncline on a basement that contained phase 1 and 2 folds and subsequently was deformed by phase 3 structures is an interesting interpretation. The foregoing observations, however, indicate that a phase 3 syncline does not exist within the present outcrop of the Slocan Group north of the Nelson batholith. Moreover, complexities of the structure are such that it is difficult to be sure that no phase 1 or phase 2 folds are present within the Slocan Group. Many of the interpretations of Ross and Kellerhals are highly speculative and fail to explain the field facts. Many of the facts have been misrepresented. —Author's conclusions

04205 **Gabrielse, H.; Blusson, S. L.** Geology of Coal River map-area, Yukon Territory and district of Mackenzie (95D): Canada Geol. Survey Paper 68-38, 22 p., illus., geol. map, 1969.

The area mapped lies within a region of subdued mountain ranges and ridges, separated by broad, drift-filled, well-forested valleys. The entire area was covered by at least one advance of Cordilleran ice. The region is mainly one of miogeosynclinal deposition. Strata range in age from late Proterozoic to Carboniferous or possibly Permian. Extrusive, basic volcanic rocks are dated stratigraphically as late Proterozoic and/or Early Cambrian, late Early Cambrian, and Middle Ordovician. —Authors' abstract

03721 **Gair, Jacob E.; Klemic, Harry.** Iron resources in the Irving Formation, *in* Mineral resources of the San Juan primitive area, Colorado: U.S. Geol. Survey Bull. 1261-F, p. F43-F50, illus., tables, 1969.

The Irving Formation contains schists, greenstones, and subordinate quartzites —mainly unstratified metavolcanic rocks intruded by other metaigneous rocks —characterized by rather uniform compositions and a wide variety of textures. Dur-

ing reconnaissance, iron-formation and similar laminated magnetic rock, containing somewhat less than 15 percent Fe, were found on five of the ten traverses. Results of chemical analyses indicate that some rock, originally named as iron-formation on the basis of appearance and magnetic properties, does not contain sufficient iron to be so classified. None of the units sampled can be classed as iron ore deposits of economic value.—MCM

03861 **Galbreath, Edwin C.** Cylindrodont rodents from the lower Oligocene of northeastern Colorado: Illinois Acad. Sci. Trans., v. 62, no. 1, p. 94-97, illus., tables, 1969.

Pseudocylindrodon sp. differs from *P. neglectus* in having a narrower incisor, incisor capsule, and mental foramina under the diastema. The geologically youngest specimens of *Cylindrodon fontis* have a weak to strong spur extending posteriorly into the central basin of the cheek teeth.—Author's abstract

04137 **Galbreath, Edwin C.** Gastropods from the Tertiary deposits of northeastern Colorado: Illinois Acad. Sci. Trans., v. 62, no. 1, p. 91-93, illus., 1969.

Oligocene Polygyridae, Zonitidae, Endodontidae, Succineidae, Pupillidae, and Miocene Succineidae are reported from northeastern Colorado. —Author's abstract

04046 **Galehouse, Jon S.** Counting grain mounts—Number percentage vs. number frequency: Jour. Sed. Petrology, v. 39, no. 2, p. 812-815, 1969.

Quantitative mineralogical analysis of grain mounts results in either a number percentage or a number frequency. The number percentage is obtained when all the grains on the slide or all the grains in representative portions of the slide are counted. The number percentage is solely a function of the numerical abundance of the mineral grains on the slide. The number frequency is obtained when the grains on the slide which intersect the cross hairs along linear traverses are counted. The number frequency is a function of both the numerical abundance of the mineral grains and the grain size but is distinctly different from either number percentage or area percentage. —Author's abstract

03673 **Galton, Peter M.** The pelvic musculature of the dinosaur *Hypsilophodon* (Reptilia:Ornithischia): Postilla, no. 131, 64 p., illus., 1969.

The pelvic musculature of *Hypsilophodon* (Lower Cretaceous, Europe), the most primitive known ornithopod dinosaur, is reconstructed by comparisons with the living alligator (representing Crocodilia, the only extant order of subclass Archosauria, to which the dinosaurs belong), and with birds, which are archosaurian derivatives. Evidence shows that: the prepubic process, diagnostic of an ornithischian, did not provide the main support for the abdomen; the abdomen was large and extended ventral to the pelvic girdle, with a strong M. rectus abdominis; an explanation is given of the necessary changes in position of muscle insertions before the pubis could change position to lie close to the ischium in later ornithischians and birds. Galton's interpretations differ considerably from those of Romer (1927).—VMJ

Garde, Subhash C. *See* Negi, Janardan G. 04051

Gardner, J. S. *See* McPherson, H. J. 04136

04199 **Garvin, Robert F.** Stratigraphy and economic significance, Currant Creek Formation, northwest Uinta Basin, Utah: Utah Geol. and Mineralog. Survey Spec. Studies 27, 62 p., illus., tables, geol. map, 1969.

This formation, Late Cretaceous-Eocene in age, crops out on the southwest flank of the Uinta Mts. in Wasatch and Duchesne Counties, is unconformable upon the Mesaverde Formation and beneath the Uinta Formation. Tentatively correlated with several formations of the Wasatch Plateau and with the Wasatch Formation of the Uinta Basin, the lower part is predominantly sandstone and conglomerate, the upper mainly sandstone, siltstone and shale; sedimentary textures and structures are described. The formation, 4,800 feet thick in the Currant Creek area, thins eastward

to a feather edge. A subsurface fault, believed to be north-dipping reverse, follows the NE–SW axis trace of the Uinta Basin. In the Currant Creek and Uinta Formations in the Duchesne River-Little Valley area, oil-impregnated sandstones of possible value may also be a clue to deep oil accumulation in the region. —GDC

Gaskill, David L. *See* Ratté, James C. 03723

04241 **Gealy, E. L.; Davies, T. A.** How the scientific work is carried out: Ocean Industry, v. 4, no. 5, p. 59-61, illus., 1969.

About 50 years ago modern techniques for geophysical exploration began to take shape. First the echo sounder yielded a continuous profile record, then seismic, magnetic, and gravity techniques were developed. Now, direct evidence of the nature of the rocks in the subsea bottom is published by the Deep Sea Drilling Project every six months, and indicates their physical properties, composition, paleontology, and chemistry of interstitial solutions. —ESL

Geiss, J. *See* Balsiger, H. 03851

Geiss, J. *See* Eugster, O. 04057

04079 **Gendzwill, D. J.** A gravity survey in the Amisk Lake area, Saskatchewan, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 263-290, illus., table, 1969.

A gravity survey was carried out over an area of about 200 sq mi near Amisk Lake, Saskatchewan. The gravity field was found to be almost wholly determined by the densities of outcropping rock units assuming moderate extrapolations to depth. The acidic to basic volcanic and intrusive rocks of the Amisk group need extend to depths ranging from 3 to 4.7 km to explain the gravity anomalies. Below this depth the volcanic rocks either rest on lighter rocks or have substantial quantities of acidic material emplaced in them, suggesting that basic Amisk rocks grade downward into Kisseynew type material. Seismic data, though scanty, tend to support this conclusion. A gravity interpretation chart is presented for determining the thickness of a slab with uniformly varying density. —*from* Author's abstract

04264 **George, F.** Notes on some glaciation features of Ubekendt Ejland, West Greenland: Geog. Jour., v. 135, pt. 1, p. 61-65, illus., 1969.

The cirque glaciers of Igdlungnap Qaqa and the morainal deposits from earlier advances and retreats indicate a phase of advance subsequent to the general deglaciation of the island after the retreat of the Greenland ice sheet. Peculiar topographic lineaments in the Igdlorssuit area, as well as peculiar drainage patterns, and perhaps also valley steps, may be attributed to a local fault pattern, but also may be a result of glacial action. The erosion surface on the island, overlain by glacial debris, has been modified by the ice advance and by the deposition of till. It has since been exposed in the valleys by postglacial rejuvenation. —HRC

04165 **Giardini, A. A.** The nature of granodiorite under triaxial stress and a possible model for seismic disturbances: Southeastern Geology, v. 10, no. 3, p. 125-148, illus., 1969.

In experimental data for granodiorite, two distinct modes of failure occur alternately with increasing mean confining stress: brittle shear characterized by an audible shock, and relatively quiet slip shear. In a failure diagram, with a mean confining stress of 60 kb considered in terms of equivalent terrestrial depth, a correlation is found with the pattern of terrestrial seismic activity, which apparently continues in speculative extrapolation to higher stress levels. Hypothetical strain release energies for a subsurface 50 × 10 km fracture agree with reported strain release energies of earthquakes. If the model, based only on failure characteristics of granodiorite, can be shown to have general applicability for subsurface igneous rock, it may provide a framework for an approximate capability to predict a future earthquake in a region of well-documented activity. —*from* Author's abstract

04204 **Gibson, D. W.** Triassic stratigraphy of the Bow River-Crowsnest Pass region, Rocky Mountains of Alberta and British Columbia: Canada Geol. Survey Paper 68-29, 48 p., illus., 1969.

The Spray River Group is divided into two distinct formations in the Bow River-Crowsnest Pass region of Alberta and British Columbia. The upper, Whitehorse Formation, consists of light grey- to buff-weathering, calcareous and dolomitic sandstone with minor amounts of sandy to silty dolomite. The underlying Sulphur Mountain Formation, which is divisible into four members at most localities, comprises a sequence of dark grey- to brown-weathering siltstone, silty and sandy limestone, shale, and some dolostone. This preliminary paper provides detailed information on the character, distribution, age and stratigraphic relationships of Triassic rocks in southwestern Alberta and southeastern British Columbia. —Author's abstract

04086 **Gilliland, J. A.** A proposed ore control at the Coronation mine, Saskatchewan, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 181-199, illus., tables, 1969.

Mineralogical cross sections of orebodies on the 300-, 600-, and 900-ft levels of this mine have centers of mineralization. The maximum concentration of chalcopyrite occurs closest to these centers, with pyrite and pyrrhotite concentrated some distance away. Magnetite is farthest from the centers. A hydrous halide fluid model, established to explain the mineralogy by action of temperature gradients, was unsuccessful; likewise, the action of diffusion alone cannot explain mineral distribution. The concept of attenuation is introduced—i.e., the rate of diffusion of a particle species is related to the product $r^2M^{0.5}$, where r is the particle radius and M is its molecular weight. Attenuation, when considered with the action of the temperature gradient, can be used to explain the mineralogy in this assumed model. —*from* Author's abstract

04245 **Giovanni, Baria; Boshkov, Stefan H.** Two-dimensional photoelastic analysis of gravity-loaded rock structures using gelatin mixture models: Soc. Mining Engineers Trans., v. 244, no. 1, p. 99-115, illus., 1969.

The application is considered of gelatin mixture models to the study of factors such as gravity effects, tectonic and residual stresses, anisotropy, physical nonlinearity, time-dependent behavior of a rock mass and connectedness of geologic space. Similitude relations between model and prototype are discussed with reference to the constitutive equations describing physical behavior of a rock mass. The interaction between two openings in a linearly elastic medium, under conditions of plane strain, is used as an illustrative example with a view to describing the history of stress and deformation changes in the rock medium and lining around a drift. —*from* Authors' abstract

Glancy, P. A. *See* Walters, Kenneth L. 04203

03738 **Glancy, Patrick A.** A mudflow in the Second Creek drainage, Lake Tahoe basin, Nevada, and its relation to sedimentation and urbanization, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C195-C200, illus., table, 1969.

A mudflow of more than 50,000 cu yd occurred in the 1.5 sq mi Second Creek basin on August 25, 1967, after an intense thundershower. Although it originated naturally, its path was affected by manmade features; it damaged real estate and roadways in the lower part of the drainage, polluted Lake Tahoe, and probably is typical of one believed-common erosional process. The sequence includes sheet and rill erosion of nonforested uplands, downstream channel erosion that flushes out alluvium previously accumulated as a result of normal runoff and mass wasting, and extensive deposition along flatter and lower part of the drainage. Estimates suggest that sheet and rill erosion of the upper basin contributed 60-80 percent of the debris, the rest derived from the main channel. The event caused landscape denudation averaging about 0.02 ft over the basin. Results influenced design of drainage structures for a new highway route.—*from* Author's abstract

Glover, Lynn, 3d. *See* Tobisch, Othmar T. 03827

Glover, Richard B. *See* Naughton, John J. 03906

Gloyna, Earnest F. *See* Shih, Chia-Shun. 04275

04196 **Godwin, H.** The value of plant materials for radiocarbon dating: Am. Jour. Botany, v. 56, no. 7, p. 723-731, table, 1969.

Annual crops and individual tree rings allow yearly fluctuations in atmospheric radiocarbon concentration to be followed, and coordination with dendrochronology affords an extremely powerful means of refined carbon dating and extending its application to paleoclimatology. Peat mires have great advantage for coordinated research involving carbon dating and pollen analysis and other fields of Quaternary research. Allochthonous origin, mixing, and the incorporation of ancient carbon by the "hard-water error" must be reckoned with in organic lake muds; marine vegetation suffers these drawbacks to an even greater degree. Misassociation of an event with plant material involves an error beyond rectification by the laboratory, so that painstaking and informed field work is required. —*from* Author's abstract

Goel, P. S. *See* Trivedi, B. M. P. 04059

04101 **Goldring, R.** Criteria for recognizing Pre-Cambrian fossils [discussion of paper by M. M. Anderson and S. B. Misra, 1968]: Nature, v. 223, no. 5210, p. 1076, 1969.

Anderson and Misra (ibid., v. 220, no. 5168, p. 680-681, 1968) described new Precambrian fossils from Newfoundland and ascribed them to impressions of soft-bodied Metazoa, but gave no evidence for their organic origin and did not relate them to the underlying and overlying sediment. Although an organic origin cannot be disproved, the illustration given does show some striking resemblances to impressions of cone-in-cone structure. Criteria for distinguishing between organic and inorganic Precambrian macrostructures are listed. —DBV

Goldsmith, Julian R. *See* Newton, Robert C. 04209

04028 **Gopalan, K.; Wetherill, G. W.** Rubidium-strontium age of amphoterite (LL) chondrites: Jour. Geophys. Research, v. 74, no. 17, p. 4349-4358, illus., tables, 1969.

Eleven falls and three finds from the amphoterite (LL) group of chondrites have been analyzed for K, Rb, and Sr concentrations and Sr isotopic composition with negligible blank contributions. The samples measured show a sufficiently good spread in their Rb-Sr ratios to define a good isochron with a slope of 0.0654 ± 0.00037 (1σ) and an intercept of 0.7005 ± 0.00015. Subject to the assumption that it is meaningful to consider these points as representing cogenetic systems with varying Rb/Sr ratios, this slope yields an age of $4.56 \pm 0.150 \times 10^9$ yr ($A = 1.39 \times 10^{-11}$ per yr) for the amphoterites. Because of the brecciated appearance of these meteorites and because in some cases the Rb/Sr ratio varies within the meteorite, the extent to which this assumption is valid is unclear. —*from* Authors' abstract

03728 **Gordon, Mackenzie, Jr.** Introduction, Chap. A *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 1-7, 1969.

In 1910, G. H. Girty published a paper on the fauna of the Fayetteville Shale of northern Arkansas and northeastern Oklahoma in which he described 110 new taxa of fossil invertebrates. He did not, however, divulge the collecting localities or illustrate the species. The present study by five U.S. Geological Survey specialists provides this information for the corals, pelecypods, gastropods, trilobites, and ostracodes in the fauna and fits them into the present scheme of classification. The introductory part outlines the problem, discusses the stratigraphy of the Fayetteville Shale, and records the collecting localities.—GM

03732 **Gordon, Mackenzie, Jr.** Trilobites, Chap. E *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 35-39, illus., 1969.

Griffithides mucronatus, the sole trilobite described by G. H. Girty in his preliminary paper on the Fayetteville Shale fauna, is redescribed, figured, and its occurrence documented. Girty's species was reassigned to the genus *Paladin* by Weller. —Author's abstract

04190 **Goudarzi, Gus H.** Geologic map of the Equality quadrangle, western Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-815, scale 1:24,000, section, text, 1969.

The principal mineral resource of the Equality quadrangle is coal; the No. 9 bed, about 4.5 feet thick, underlies the southern three-fourths of the area, and the No. 14 bed, as much as 9 feet thick, underlies much of the southern half. Oil and natural gas have been produced in several fields from the Tar Springs, Hardinsburg, and Sample Sandstones, and the Ste. Genevieve Limestone; shows have been reported in rocks of the Big Clifty Sandstone Member of the Golconda Formation. —MCM

Grabowski, Robert J. *See* Rittenhouse, Gordon. 03843

Gray, Fenton. *See* Yeck, Ronald D. 04254

03874 **Green, Trevor H.** High-pressure experimental studies on the origin of anorthosite: Canadian Jour. Earth Sci., v. 6, no. 3, p. 427-440, illus., tables, 1969.

Experimental crystallization of anhydrous synthetic quartz diorite, gabbroic anorthosite, and high-alumina basalt preclude, for the latter two, any major trends towards alumina enrichment and derivation of anorthosite plutons at crustal or upper mantle depths. The quartz diorite experiments suggest that anorthosite complexes may form as a crystalline residuum from the partial melting of a lower crust of overall andesitic composition or from fractionation of an andesitic magma. In either case a large separation of plagioclase crystals occurs, together with subordinate pyroxenes and ore minerals. Where these processes have operated in the crust, anorthositic rocks may be left as the main component of the lower crust, while the low melting acidic portion has intruded to higher levels.—*from* Author's abstract

Greenfield, R. J. *See* Capon, J. 03974

03750 **Greenland, L. Paul; McLane, J. E.** Determination of germanium in silicates by neutron activation analysis, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C152-C154, table, 1969.

A neutron activation procedure with a detection limit of 0.2 nanogram of Ge has been devised for the analysis of germanium in rock samples. After a 5-minute irradiation, the sample is fused with $NaOH\text{-}Na_2O_2$ in the presence of a germanium carrier. The fusion cake is dissolved and made 9*M* in HCl. Germanium is extracted to carbon tetrachloride, washed, and back-extracted to water. The germanium separated in this way is radiochemically pure and may be counted by either β^- or γ techniques. After counting, the chemical yield of the procedure is determined by re-irradiation and counting. Determinations of eight U.S. Geological Survey standard rocks by this method are reported.—Authors' abstract

04106 **Gregory, Joseph T.** Evolution und interkontinentale Beziehungen der Phytosauria (Reptilia) [with English summ.]: Palaont. Zeitschr., v. 43, nos. 1-2, p. 37-51, illus., 1969.

The Phytosauridae, a rapidly evolving family of crocodile-like reptiles, permit more correlation between continental Triassic deposits of North America and Europe than any other groups of fossils. *Paleorhinus* occurs in the Popo Agie Formation of Wyoming, the lower part of the Dockum in Texas, and in Germany. European *Paleorhinus* specimens are slightly advanced over the American forms. The last known phytosaurs occur in the Rheat Sandstone of Europe; fossil vertebrates provide no clear evidence of equivalent deposits in America. Phytosaur remains from North Africa, India, and China are either insufficiently known at present or too incomplete to permit detailed correlations. —*from* Author's English abstract

03697 **Greiner, Gary O. G.** Recent benthonic foraminifera—Environmental factors controlling their distribution: Nature, v. 223, no. 5202, p. 168-170, illus., 1969.

The dominance distributions of the three major groups of foraminifera in the shallow water bodies adjacent to the Gulf of Mexico have been mapped, and associated changes in paralic environments have been evaluated. It is found that agglutinated forms dominate in areas of low, hyaline calcareous types in areas of intermediate, and porcellanous forms in areas of high temperature and salinity. The same correlations exist on a local scale within each bay or lagoon. This dominance sequence can be explained by a regular southward increase in available calcium carbonate, the solubility of which is controlled by temperature and salinity.—DBV

Greick, Irving W. *See* Segeler, Curt George. 03951

03744 **Grice, R. H.** The effect of temperature-humidity on the disintegration of nonexpandable shales: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 69-77, illus., tables, 1968 [1969].

This paper reports the results of preliminary work using an easily applied method of rock quality assessment of Ordovician Utica shales in the St. Lawrence Lowlands. Rock samples were subjected to wetting and drying cycles of various intensities and durations. Disintegration was expressed as the change in the surface area of samples and was determined by weighing samples after they had been exposed in an atmosphere of 100 percent humidity. Samples increased their sorbed water content by 10 to 50 percent in the period during which visual disintegration took place. —Author's abstract

Griffitts, Wallace R. *See* VanHorn, Richard. 04191

03980 **Grisafe, David Anthony.** Crystal chemistry and color in apatite [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4637B, 1969.

03740 **Grove, D. B.; Rubin, Meyer; Hanshaw, B. B.; Beetem, W. A.** Carbon-14 dates of ground water from a Paleozoic carbonate aquifer, south-central Nevada, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C215-C218, illus., table, 1969.

Radiocarbon determinations were used to estimate the ages of ground water from the Paleozoic aquifer underlying the Nevada Test Site and adjacent areas. A generally good correlation exists between the carbon-14 dates and the current hydraulic interpretations; but the aquifer is heterogeneous and is insufficiently defined to permit detailed predictions of ground-water velocities or flow patterns.—Authors' abstract

Gude, Arthur J., 3d. *See* Sheppard, Richard A. 04242

04022 **Guilcher, André.** Pleistocene and Holocene sea level changes: Earth-Sci. Revs., v. 5, no. 2, p. 68-97, illus., 1969.

The classic glacio-eustatic theory, as it was conceived by Deperet, is briefly presented, and its objections are discussed. New considerations concerning uplifts have altered but not eliminated the earlier ideas; the C-14 and Th-230/U-234 techniques have allowed more accuracy in dating former sea levels. Two interglacial high stands are especially noteworthy. Low Quaternary levels are reviewed. During one glaciation at least, the sea level was certainly depressed 100 m, probably 150 m, and possibly 200 m, as drowned valleys and submerged strandlines are still recognizable. The rise of sea level after the Würm can be followed in detail in some areas such as the Atlantic and Gulf coasts. There is much discussion, however, about the problem of the maximum level reached by this transgression; some think that the sea surpassed by 1-3 m the present datum.—*from* Author's summary

Guillier, M. T. *See* Delibrias, G. 03942

03767 **Gulbrandsen, R. A.; Reeser, D. W.** An occurrence of Permian manganese nodules near Dillon, Montana, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C49-C57, illus., tables, 1969.

Concentrically ringed manganese nodules, similar in form to many found on modern ocean and sea floors, occur in a very fine grained argillaceous sandstone bed of the Permian Park City Formation near Dillon, Mont. They are enriched in many rare elements and contain as much as 2.5 percent zinc, 1.3 percent nickel, and 0.22 percent cobalt. The manganese minerals are chalcophanite and todorokite. The nodules probably formed in a shallow marine oxidizing environment on the western side of the Permian sedimentary basin. The occurrence of an appreciable amount of fluorite in the bed suggests that the water was saline.—Authors' abstract

04109 **Gutdeutsch, Rudolf.** On Rayleigh waves in a wedge with free boundaries: Seismol. Soc. America Bull., v. 59, no. 4, p. 1645-1652, illus., 1969.

Seismic modeling experiments have shown that a Rayleigh wave traveling toward the corner of a small angle wedge with free boundaries decomposes into two waves whose orbital motions are symmetric and antisymmetric with respect to the bisector of the wedge. Their local phase velocities are respectively equal to the phase velocities of the symmetric and antisymmetric Rayleigh mode in a plate with parallel boundaries where the thickness of the plate is equal to the local thickness of the wedge. This experimental result has been used to construct an approximation theory to describe the propagation of Rayleigh waves in a wedge. In this paper synthetic seismograms and particle motions computed with their theory are compared with seismograms produced by laboratory models. —Author's abstract

03699 **Gutstadt, Allan M.; Schopf, J. William.** Possible algal microfossils from the late Precambrian of California: Nature, v. 223, no. 5202, p. 165-167, illus., 1969.

Crystalline chains interpreted as biological in origin, from the late Precambrian Beck Spring Dolomite of southern California, are described. In size, shape, and general organization these chains are comparable with certain modern and fossil filamentous algae and bacteria, and they occur within silicified stromatolites, an association consistent with an algal origin.—DBV

Hagen, P. J. *See* Jeffery, P. M. 04170

04074 **Halls, John R.; Hoyt, John H.** The significance and limitations of statistical parameters for distinguishing ancient and modern sedimentary environments of the lower Georgia Coastal Plain: Jour. Sed. Petrology, v. 39, no. 2, p. 559-580, illus., tables, 1969.

Samples from six Pleistocene barrier coastlines and the Holocene coast are used to evaluate the statistical parameters for distinguishing ancient and modern sedimentary environments. The sediments from each barrier coastline can be divided into lagoon-salt marsh and barrier island facies. The former include estuarine and tidal channel sediments whereas the barrier facies also include dune, littoral, shallow neritic, and offshore channel deposits. Barrier island sands are better sorted than those from the lagoon-salt marsh, the coarsest being found in tidal inlets and channels, and about 70 percent of the samples are negatively skewed. More than 90 percent of the Holocene beach sands are negatively skewed, but about 70 percent of the dune sands show positive skewness. The sign of skewness is related to the energy variations in different sedimentary environments. —*from* Authors' abstract

Halt, Mortimer H. *See* Lucchitta, Ivo. 03752

04077 **Hajnal, Zoltan.** Paleomagnetic study of the Coronation mine area, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 241-252, illus., 1969.

Magnetic studies have been carried out on 88 surface and 157 underground samples from the Coronation mine area. A good correlation was found between the

titaniferous constituent of the rocks and the intensity of magnetization. From the direction of the remanent magnetism, two virtual geomagnetic poles were determined—lat 12°54′ N., long 158°17′ W, and lat 23°42′ N, long 163°45′ W. The sulfide ore specimens showed anisotropic susceptibility characteristics. A relationship was found between the measured maximum susceptibility values of the ore specimens and the direction of the tectonic forces which are considered to have formed the structure at the Coronation mine. —*from* Author's abstract

Hall, John W. *See* Jain, Raj K. 04195

03830 **Hall, Wayne E.; Friedman, Irving.** Oxygen and carbon isotopic composition of ore and host rock of selected Mississippi Valley deposits, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C140-C148, illus., tables, 1969.

Variations in carbon and oxygen isotopic composition of ore and host rock of selected orebodies in Upper Mississippi Valley and Tri-State districts, were investigated. Systematic decreases in δO-18 and δC-13 values in limestone and dolomite host rock toward ore are interpreted as diminishing isotopic fractionation with increasing temperature. Late-stage ore minerals have a broad scatter of δO-18 and δC-13. Calculated δO-18 of late-stage mineralization ore fluid is +0.4 to -1.6 per mil for Upper Mississippi Valley district and -3 per mil for Tri-State, values considered reasonable for ore fluid of hot oil-field brine mixed with meteoric water during late-stage mineralization. The δO-18 and δC-13 of carbonate host rocks of Mississippi Valley deposits do not seem practical as ore guides because the limestone area depleted in these isotopes is small.—*from* Authors' abstract

04154 **Halls, H. C.** Compressional wave velocities of Keweenawan rock specimens from the Lake Superior region: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 555-568, illus., tables, 1969.

In certain instances, formation velocities are sufficiently distinct to permit reliable geological identification of seismic refractors in the Lake Superior basin. Slightly metamorphosed volcanics, such as the Portage Lake series of the Michigan copper district, cannot be responsible for the "upper refractor" velocities of 6.6-6.9 kmps observed at depths of about 10 km beneath Lake Superior. Amphibole-bearing volcanics, hitherto unreported, were sampled in the basal parts of the Keweenawan extrusive sequence, and represent a higher grade of regional metamorphism than commonly found in the Portage Lake Series. These must be seriously considered as the cause of the upper refractor. —*from* Author's abstract

03676 **Hamelin, Louis-Edmond.** Bibliographie des publications de Louis-Edmond Hamelin, Pt. 1: Rev. Géographie Montréal, v. 23, no. 1, p. 75-82, 1969; Pt. 2, no. 2, p. 179-185, 1969.

03811 **Hamilton, Thomas D.** Glacial geology of the lower Alatna Valley, Brooks Range, Alaska, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 181-223, illus., tables, 1969.

Glaciers reached the lower Alatna Valley in three episodes. During the oldest, piedmont glaciers extended 60 miles south of the range and covered most of the Koyukuk Lowlands. The later Kobuk glaciation advanced this far, then retreated, then advanced 35 miles south of the range. Itkillik drift, the youngest, is subdivided into four moraine belts, the oldest and most extensive extending 30 miles south of the range. Subdivisions and correlations of the glacial sequence are based on extent and position of the drift sheets, inferred glacial regimens, postglacial modification of glacial deposits, radiometric dates, and ice limits within the upper Alatna Valley. The four Itkillik episodes are equivalent to those in the Anaktuvuk Valley, and radiocarbon dates suggest a Wisconsin age for them. The Kobuk is early Wisconsin, and the oldest is Illinoisian.—*from* Author's abstract

03969 **Han, Jerry; Calvin, Melvin.** Occurrence of C_{23}-C_{25} isoprenoids in Bell Creek crude oil: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 733-742, illus., table, 1969.

The aliphatic hydrocarbon content of the crude oil from the Bell Creek oil field of Powder River County, Montana, has been studied. Mass spectrometric fragmentation patterns indicate the presence of all 12 isoprenoid hydrocarbons ranging from C_{14} to C_{25} as well as head-to-tail conformations. Precursors of the compounds are discussed. —Authors' abstract

04140 **Handfield, Robert C.** Early Cambrian coral-like fossils from the northern Cordillera of western Canada: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 782-785, illus., 1969.

Tabulaconus kordeae, n. gen., n.sp., is a coral-like fossil found in the Sekwi Formation, Mackenzie Mountains, District of Mackenzie and the Atan Group, Cassiar Mountains, British Columbia. The species consists of small, conical shells with a layered external wall and abundant tabulae. It is placed in the family Gastroconidae, previously known only from Siberia. Associated Archaeocyatha and Trilobita prove its Early Cambrian age. —Author's abstract

03677 **Hanks, Thomas C.; Anderson, Don L.** The early thermal history of the Earth: Physics Earth and Planetary Interiors, v. 2, no. 1, p. 19-29, illus., tables, 1969.

The early thermal history of the Earth is reconsidered with the constraint that core formation occurs before emplacement of the oldest known rock possessing remanent magnetism. For all cases, the Earth must accrete in a period of 500,000 years or less (4.5 b.y. ago) to fulfill this constraint. Partial melting of silicates upon accretion is implied; core formation and large-scale differentiation of the Earth at that time are a distinct possibility. Thermal models using recent determinations of U, Th, and K from oceanic lherzolites and evidence from continental heat flow imply that the Earth accreted in 200,000 years or less and that large-scale differentiation upon accretions is likely. This conclusion vindicates the hot origin hypothesis.—*from* Authors' abstract

Hanshaw, B. B. *See* Grove, D. B. 03740

03797 **Hanshaw, Bruce B.; Hill, Gilman A.** Geochemistry and hydrodynamics of the Paradox basin region, Utah, Colorado, and New Mexico, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 263-294, illus., tables, 1969.

The aquifer systems studied in this region were: (1) Mississippian rocks, (2) Pinkerton Trail Limestone, (3) Paradox Member of the Hermosa Formation, (4) Honaker Trail Formation, and (5) Permian rocks. The direction of ground-water movement in each analyzed unit is principally southwestward toward topographically low outcrop areas. Within the basin, the direction may be different owing to intrabasin recharge areas or local obstructions such as faults or dikes. Potentiometric maps for each unit are prepared. With a few exceptions, most wells in rocks above the Pennsylvanian contain fresh to moderately saline water; in only a few cases are true brines reported. Most water from below the Permian are brines of NaCl type.—*from* Authors' summary

Hanson, Robert F. *See* Keller, W. D. 04167

Harmon, W. R. *See* Karttunen, J. O. 04328

03990 **Harrington, Jonathan Waldo.** Taxonomy, evolution and paleoecology of the rhynchonellid brachiopods of the New York Senecan (Upper Devonian) [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4711B, 1969.

04337 **Harris, John M.; Wood, Albert E.** A new genus of eomyid rodent from the Oligocene Ash Spring local fauna of Trans-Pecos Texas: Texas Memorial Mus. Pearce-Sellards Ser., no. 14, 7 p., illus., table, 1969.

This paper describes a new genus and species of eomyid rodent, *Meliakrouniomys wilsoni* from the Ash Spring local fauna, the latest vertebrate faunule from the Vieja Group of Trans-Pecos Texas. The teeth indicate that it is an eomyid rodent in process of tooth pattern simplification. Resemblances in tooth pattern and jaw structure to

heteromyids and eomyids suggest that *Meliakrouniomys* may represent a transitional stage between the two families. —Authors' abstract

03929 **Harrison, A. E.** Glacial activity preceding the 1956 Muldrow Glacier surge in Alaska, *in* Symposium on surging glaciers, Banff, Alberta, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 1001-1007, illus., 1969.

Ice thickening began before 1947 with a wave motion of about 250 m per year between 1948 and 1952. The ice opposite McGonagall Pass thickened spectacularly after 1954 and a lateral ice cliff extended at least 1.6 km beyond the pass when the ice began its surge in 1956. Air photographs before and after the surge suggest that several small tributaries were also rejuvenated just before the surge occurred. These observations point to the possibility of climatic synchronism in the Alaskan Range and southern ranges of North America.—*from* Author's abstract

Harrison, C. G. A. *See* Ball, M. M. 03698

03847 **Harrison, C. G. A.** What is the true rate of reversals of the Earth's magnetic field?: Earth and Planetary Sci. Letters, v. 6, no. 3, p. 186-188, illus., tables, 1969.

Known reversals of the Earth's magnetic field occur at a rate of five per million years. However, the methods whereby the reversal pattern has been established act as a high frequency cut-off filter and will not record two reversals as separate if they occur close to each other. It is thus probable that the true reversal rate is much greater than five per million years. By comparing the observed distribution of polarity interval lengths with a theoretical distribution, it is shown that the most likely rate is close to ten per million years.—Author's abstract

Hart, S. R. *See* Brooks, C. 03835

Harward, M. E. *See* Chichester, F. W. 04330

03841 **Hasegawa, H. S.; Whitham, K.** Theoretical response of a seismograph at Yellowknife, Northwest Territories, to an underground explosion at the Nevada Test Site: Canadian Jour. Earth Sci., v. 6, no. 3, p. 517-520, illus., 1969.

A comparison of the theoretical response of the short-period, vertical-component seismograph at Yellowknife to an underground explosion originating at the Nevada Test Site with a real seismogram indicates that the prime contributors to complexity are likely due to the following: (a) complex crustal reverberations at the N.T.S., (b) different phase arrivals, and (c) signal-generated noise at Yellowknife.—Authors' abstract

03991 **Hassan, Mamdouh Abdel-Ghafoor.** On metamorphism of Jurassic volcanic rocks in the foothills of the Sierra Nevada, California, with a review of stratigraphy and structure [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4712B, 1969.

04117 **Hatten, Charles W.** Noel K. Brown, Jr. (1925-1968): Micropaleontology, v. 15, no. 3, p. 380, portrait, 1969.

03896 **Hattersley-Smith, G.** Recent observations on the surging Otto Glacier, Ellesmere Island, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 883-888, illus.; discussion, p. 888-889, 1969.

Air photographs show that the Otto Glacier in northwestern Ellesmere Island started to surge sometime between 1950 and 1959, with the result that the terminus advanced about 3 km as a floating ice tongue. Maps prepared from the 1959 photographs and from additional photographs taken in 1964 show a further advance of 2-3 km. Information from a subglacial relief map of the terminal part of the glacier, constructed from the results of radio-depth sounding over the glacier in 1966, may have a bearing on the mechanism of glacier surges. Other glaciers in northern Ellesmere Island show features indicative of past surges.—Author's abstract

03775 **Haubrich, Richard A.; McCamy, Keith.** Microseisms—Coastal and pelagic sources: Rev. Geophysics, v. 7, no. 3, p. 539-571, illus., table, 1969.

Wave-number frequency spectra of seismic background recordings from LASA were used to study source locations of different wave types in the frequency band 40-500 mHz; microseisms consist of Rayleigh and Love type surface waves and compressional body waves. Peak power band near 140 mHz and lower frequency band near 70 mHz consist of fundamental Rayleigh waves, often from the same direction; average directional properties are similar, indicating coastal sources. Love and higher mode Rayleigh waves in some instances come from the same coastal directions as the fundamental mode; compressional body-wave sources occur near storms both in coastal and pelagic regions. Pelagic storm sources were found only at frequencies that were high compared with double the frequency of ocean waves having a group velocity equal to storm velocity.—*from* Authors' abstract

Hauser, Victor L. *See* McMillian, Leslie G. 04314

04300 **Haye, Edward F.** Pinnacle reefs, their gravity response: Tulsa Geol. Soc. Digest, v. 36, p. 53-72, illus., 1968 [1969].

Gravity will generally cost between 1/16th to 1/17th that of a comparable area of seismic coverage. The author has been searching for reefs with gravity since 1964, and has found that each area is different and the anomaly associated with reefs in one place will be different in another. Reef examples studied are in the Illinois basin, in Saskatchewan, and west-central Texas. —ESL

03768 **Hazel, Joseph E.** Faunal evidence for an unconformity between the Paleocene Brightseat and Aquia Formations (Maryland and Virginia), *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C58-C65, illus., table, 1969.

It has recently been suggested that the lower Danian Brightseat Formation is conformable with the overlying Aquia Formation. Data from a study of the Brightseat and Aquia ostracodes and foraminifers oppose such an interpretation and indicate that a disconformity equivalent to the middle Paleocene *Globorotalia uncinata-Globigerina spiralis* and *Globorotalia pusilla pusilla-Globorotalia angulata* zones is present.—Author's abstract

03992 **Hazlett, William Henry, Jr.** Structural evolution of the Roanoke area, Virginia [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4712B-4713B, 1969.

Hedge, Carl E. *See* Noble, Donald C. 03758

Heimlich, R. A. *See* Condie, Kent C. 03846

04253 **Heise, Horst.** Where are the largest native sulphur reserves?: Oilweek, v. 20, no. 7, p. 23-25, 34, illus., 1969.

Sverdrup basin in the Arctic Archipelago probably holds the world's largest reserves of sulfur. The occurrence of sulfur is tied to evaporite piercement structures, like those in the Gulf Coast. If expectations of reserves, and permanent transportation routes in the Arctic, are fulfilled, Canada could be the world's leading sulfur producer in the "eighties". Possibilities of sulfur production were late being recognized because the plugs at first were considered anhydrite or gypsum, not salt, and most sulfur comes from caprock associated with salt domes. The sulfur-bearing zone is usually from 25 to 300 feet thick. Only 22 of the 230 domes known in Texas and Louisiana, produce sulfur. The Sverdrup basin domes came up through the Cretaceous as well as the Tertiary, allowing longer time for diagenesis. Sulfur has been found on five domes. —ESL

03905 **Helgeson, Harold C.** Thermodynamics of hydrothermal systems at elevated temperatures and pressures: Am. Jour. Sci., v. 267, no. 7, p. 729-804, illus., tables, 1969.

Sufficient thermodynamic data are available to permit calculation of equilibrium constants for a large number of hydrothermal reactions. Where the data are incomplete, the calculations involve entropy estimates, application of average heat capacities, and/or assumptions concerning the temperature dependence of thermodynamic variables and the relative importance of electrostatic and non-electrostatic interaction among the species. Temperature stoichiometric activity coefficients for individual ions can be calculated using deviation functions computed from osmotic coefficients for concentrated NaCl solutions. The results of such calculations, together with computed heat capacities, enthalpies, entropies, and equilibrium constants for many hydrothermal species and reactions are presented in tables and diagrams.—*from* Author's abstract

Henry, K. W. *See* Opdyke, N. D. 03849

Henyey, Thomas L. *See* Brune, James N. 04053

04304 **Hewitt, Charles H.** Origin, geometry and production of a sandstone reservoir [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 92, 1968 [1969].

Hill, Gilman A. *See* Hanshaw, Bruce B. 03797

04267 **Hillard, Patrick D.** Geology and beryllium mineralization near Apache Warm Springs, Socorro County, New Mexico: New Mexico Bur. Mines and Mineral Resources Circ. 103, 16 p., illus., tables, geol. map, 1969.

Volcanic rocks exposed southeast of Apache Warm Springs include Tertiary pyroclastics, andesites, latites (older than the Datil Formation and propylitized), rhyolite tuffs, and flow rhyolites (equivalent to lower Datil and altered only locally). Quaternary Winston beds, along the west edge, consist of locally derived sandstone, siltstone, and conglomerate. Beryllium mineralization was discovered near the west end of Monticello Canyon in 1961 and later explored by drilling. The ore mineral, identified as bertrandite, is associated with widespread hydrothermal alteration of country rock and is restricted to one highly faulted and brecciated zone in an altered rhyolite tuff. The mineralized breccia contains from 0.05-2.5 percent beryllium oxide. No beryllium has been commercially produced. —*from* Author's abstract

Hines, Marion S. *See* Plebuch, Raymond O. 03711

Hines, Marion S. *See* Lamonds, A. G. 03712

03810 **Hirschfeld, Sue E.** Vertebrate fauna of Nichol's Hammock, a natural trap: Florida Acad. Sci. Quart. Jour., v. 31, no. 3, p. 177-189, table, 1968 [1969].

A native fauna trapped in a solution hole in Nichol's Hammock was studied to learn what animals were trapped in such a hole, to determine to what degree the species collected actually reflect the existing environment and fauna of the surrounding area, and to try to reconstruct the environment on species alone. All but two of the species found are still extant. Most of the fossil fauna is probably post-Columbian. Vertebrate fauna listed include Mammalia, Aves, Reptilia, Amphibia, and Pisces. Of the 35 mammalian species that now live in southern Florida, 13 were identified in the pit; the most abundant are opossums. Mammalian and herpetofauna ecologies are discussed. The trap collected a representative sample of the fauna of the whole area, not just a mesic fauna.—ESL

03880 **Hiss, William L.; Peterson, Johannes B.; Ramsey, Thomas R.** Saline water in southeastern New Mexico, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 341-360, illus., 1969.

Cl-ion concentrations in water produced from rocks of various ages and depths have been mapped in Lea County, using machine map-plotting techniques and trend analysis. Anomalously low concentrations were found along the western margin of the Central Basin Platform in Permian rocks, and may be due to preferential circulation of ground water through the more porous and permeable rocks. Approximately

20,000 water analyses collected from over 65 sources were coded, recorded, and stored. These were reduced to 6,000 representative analyses which were used.—*from* Authors' summary

Hitchon, Brian. *See* Billings, Gale K. 03853

03820 **Hodgkinson, J.** Reconnaissance seismic and magnetometer surveys in Hudson Bay, Canada, *in* Earth science symposium on Hudson Bay, Ottawa, 1968: Canada Geol. Survey Paper 68-53, p. 247-269, illus., 1969.

Results of a reconnaissance refraction survey over a portion of Hudson Bay are presented in a structural map on a deep refractor. The map is compared with a map of depth-to-basement estimates derived from an aerial magnetometer survey. The magnetic basement is 1,500 to 3,000 feet deeper than the deep refractor. The velocity of the deep refractor averages 20,200 ft per sec over the area surveyed. The refraction results in the Bay are correlated with those of a survey across the Sogepet-Aquitaine Kaskattama Province No. 1 well on the coast, where a deep refractor of similar velocity was mapped. It is concluded that the deep refractor of the coastal survey is an Ordovician limestone. It is believed that the results of the seismic and magnetometer surveys indicate over 8,000 feet of sedimentary section beneath Hudson Bay.—*from* Author's abstract

03696 **Hoefs, J.; Epstein, S.** O^{18}/O^{16} ratios of minerals from migmatites, rapakivi granites and orbicular rocks: Lithos, v. 2, no. 1, p. 1-8, illus., tables, 1969.

O-18/O-16 ratios of quartz, feldspar, biotite and garnet have been determined from three migmatites of Southern Finland. The ratios seem to represent 'mixed values' between igneous and metamorphic rocks. This can be interpreted as an indication of an out-of-equilibrium state. The δ O-18 values of feldspars from rapakivi and from orbicular rocks [Mexico, California, and Finland] are considered in the light of existing theories of formation. [All orbicular rocks have ratios consistent with igneous temperatures.]—Authors' abstract

03913 **Hofer, H.** Static correlation vital in seismic exploration: Oilweek, v. 20, no. 16, p. 18-19, illus., 1969.

Widespread use of common-depth-point techniques emphasizes need for accurate corrections. Primary reflection energy must be correctly aligned if benefits from this method are to be realized. Conventional methods of deriving statics continue to be ineffective and costly, while computer methods making use of high-graded data afforded by common-depth-point recording are desirable. A comparative study of automated, semi-automated and manual methods showed that quality of final stack sections produced by automatic techniques was as good or better than manual methods. Automated techniques also decreased processing costs.—Author's abstract

03875 **Hoffman, Paul.** Proterozoic paleocurrents and depositional history of the East Arm fold belt, Great Slave Lake, Northwest Territories: Canadian Jour. Earth Sci., v. 6, no. 3, p. 441-462, illus., 1969.

This sequence, nearly 40,000 feet thick, is an erosional remnant of an Appalachian-type geosynclinal complex. Integrated paleocurrent, stratigraphic, and sedimentological analyses reveal three stages in the depositional history: a double transgressive, pre-orogenic miogeosyncline, a regressive syn-orogenic clastic wedge, and a continental, post-orogenic taphrogeosyncline. Facies predictions based on the model provide criteria for stratigraphic correlation between East Arm and other Aphebian sequences. The prevailing depositional strike is roughly perpendicular to the tectonic strike of the East Arm fold belt. The Bear Province may have been the site of the orogenically active axial zone of the geosyncline, but that nearby part of the Churchill Province was passive until the post-orogenic stage.—*from* Author's abstract

Hogan, Austin W. *See* Dort, Wakefield, Jr. 04025

03932 **Hollin, John T.** Ice-sheet surges and the geological record, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 903-910, illus.; discussion, p. 910, 1969.

If they had occurred, ice sheet surges would have caused sea-level rises of up to 50 m from Gondwanaland and 20 m from Antarctica. The rises would have taken 100 years or less and the subsequent falls would have taken 50,000 years or so. This could explain the Carboniferous cyclothems. Tectonic activity is the alternative. Tests could show (1) if contacts correlate better with glaciation or tectonism, (2) how extensive the contacts are, (3) if there is erosion during sea-level falls, (4) if amplitudes and periods of cycles fit surges or subsidence, (5) how fast the submergences were, and (6) if any coolings began at the contacts. If surges triggered the Pleistocene ice age, interglacial pollen profiles should show rapid but temporary marine transgressions beginning at the break of the climate. Evidence occurs, but it could also be due to local downwarping. No Wisconsin surges are known.—HRC

03771 **Holman, J. Alan.** Lower Oligocene amphibians from Saskatchewan: Florida Acad. Sci. Quart. Jour., v. 31, no. 4, p. 273-289, illus., 1969.

A salamander, *Ambystoma tiheni*, n.sp., and three anurans, *Rhinophrynus canadensis* Holman, *Scaphiopus* (*Scaphiopus*) sp., and *Hyla swanstoni*, n.sp., are described from the Cypress Hills Formation, Saskatchewan. The strikingly modern nature of the fauna, of which all the genera are extant, indicates that modern subgenera and in some cases modern species groups may have been differentiated by early Oligocene times. Presence of *Rhinophrynus*, *Scaphiopus*, crocodilians and boid snakes together in the Oligocene fauna, and absence of *Rana* and *Bufo*, suggest a fairly xeric climate with sporadic and seasonal rainfall, not unlike that of the coastal lowlands of Mexico today.—VMJ

03778 **Holman, J. Alan.** A Pleistocene herpetofauna from Kendall County, Texas: Florida Acad. Sci. Quart. Jour., v. 31, no. 3, p. 165-172, 1968 [1969].

An assembly of amphibian and reptile bones from Cave Without a Name was studied; an annotated list is presented.—ESL

Holzhey, C. S. *See* Nettleton, W. D. 04287

03784 **Hooker, Marjorie.** Bibliography and index of the geology of Puerto Rico and vicinity, 1866-1968: San Juan, P. R., Geol. Soc. Puerto Rico, 53 p., 1969.

As here defined, Puerto Rico includes the island of Puerto Rico, nearby islands Desecheo, Mona, Monito, Culebra, and Vieques, and surrounding submarine areas. Citations in the bibliography are listed alphabetically by author with occasional explanatory notes. The subject and geographic indexes are based on content of papers cited rather than on titles alone.—MCM

Hoque, M. *See* Wardlaw, N. C. 04156

03834 **Horai, Ki-Iti.** Effect of past climatic changes on the thermal field of the Earth: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 39-42, illus., tables, 1969.

The effect of past climatic changes on the temperature distribution near the surface of the Earth is investigated. It is concluded that a maximum disturbance to the thermal gradient ranging from 2.7° C/km to more than 5.4° C/km is likely to occur at depths less than 1 km from the surface. Careful corrections to terrestrial heat flow measurements in previously glaciated areas are necessary to evaluate the equality of the continental and oceanic heat flow averages.—Author's abstract

03938 **Horvath, Eva V.; Field, William O.** References to glacier surges in North America, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 845-851, table, 1969.

This compilation lists reported glacier surges in North America and published references. Additional references are also given for general discussions of surge phenomena and on surges in other parts of the world.—Authors' abstract

03857 **Hörz, Friedrich.** Structural and mineralogical evaluation of an experimentally produced impact crater in granite: Contr. Mineralogy and Petrology, v. 21, no. 4, p. 365-377, illus., tables, 1969.

A crater 30 cm in diameter and 4.4 cm in depth was produced upon impact of an aluminum sphere with a homogeneous granite target. The volume excavated was 748 cm^3, the mass ejected 1933 g. The crater geometry is compared with previous laboratory experiments. Mineralogical investigations revealed that shock induced, microscopic fracturing is lowest in the direction of uniaxial compression, followed by a 45° profile. Due to reflections of stress waves at the free surface, the horizontal profile displayed the highest fracture index. Kinking of biotite was very common in samples close to the crater walls (about 50 kb). However, it faded out at a distance which corresponds to approximately 10 kb. This seems to be the lower pressure limit for the formation of kink bands under shock conditions.—Author's abstract

04067 **Hoskin, Charles M.; Nelson, Richard V., Jr.** Modern marine carbonate sediment, Alexander Archipelago, Alaska: Jour. Sed. Petrology, v. 39, no. 2, p. 581-590, illus., tables, 1969.

Surface sediment from the inner continental shelf and island beaches in the Sitka Sound area contains between 94 and 37 percent by weight carbonate, the remainder being silicate rock fragments and minerals. Sand-sized pumice is a minor constituent. These sediments are bi- and polymodial coarse skewed gravelly sands. Mud is present in trace amounts and is mostly carbonate. The carbonates are biogenic; sand-sized grains are fragmented skeletons of barnacles, echinoids, bryozoans, and mollusks. Sand-sized carbonate minerals are mostly low Mg-calcite with high Mg-calcite and aragonite as minor constituents. Aerial reconnaissance in the Sitka Sound area suggests that these carbonates are more widespread than formerly supposed. —*from* Authors' abstract

04014 **Hospers, J.; VanAndel, S. I.** Palaeomagnetism and tectonics—A review: Earth-Sci. Revs., v. 5, no. 1, p. 5-44, illus., tables, 1969.

A critical review is given of applications of paleomagnetism to tectonics in its broadest sense. Only the most general geotectonic problems, such as the hypotheses of continental drift and/or sea-floor spreading have been excluded. Studies of the following are reviewed: Newfoundland, the Lewis thrust plate, the Appalachian Mountains, the Columbia arc (northwestern U.S.A.), Japan, the Arabian peninsula, the inner Sudetic basin and the Bohemian massif, the Choc nappe (Carpathian Mountains), the Iberian peninsula, Corsica, Sardinia, the southern Alps (northern Italy) and their bearing on major shear movements in the Tethys mobile belt, anticlines of the Tadzhik depression, and the younger gabbros of Aberdeenshire, Scotland. A limited number of related problems are touched upon. —*from* Authors' summary

03804 **Howard, Hildegarde.** Avian fossils from three Pleistocene sites in central Mexico: Los Angeles County Mus. Contr. Sci., no. 172, 11 p., illus., 1969.

A small collection of avian bones from Chapala, Tequixquiac, and San Marcos represents more than twenty species, 17 of which had no previous fossil record in Mexico. Of nine extinct forms, five relate to the Pleistocene of Rancho La Brea, California or San Josecito Cave, Nuevo León; one (from Chapala) is referred to a Late Pliocene species, and three are undescribed.—Author's abstract

Hoyt, John H. *See* Hails, John R. 04074

Huneke, J. C. *See* Wasserburg, G. J. 04005

Hurley, P. M. *See* Brookins, D. G. 03858

Hurley, P. M. *See* Fairbairn, H. W. 03871

03903 **Ida, Yoshiaki.** Thermodynamic theory of nonhydrostatically stressed solid involving finite strain: Jour. Geophys. Research, v. 74, no. 12, p. 3208-3218, tables, 1969.

A thermodynamic theory under nonhydrostatic stresses is developed to discuss the role of thermodynamic functions in chemical processes, based on treatment of elasticity involving finite deformation. The chemical potential introduced by the "local equilibrium" theory is valid under certain restrictions. An expression of the chemical potential applicable to the case under a small nonhydrostatic stress superimposed on a finite hydrostatic pressure is derived. Application of the theory to crystallographic phase transformation explains spreading of transition pressure resulting from nonhydrostatic components of stress. Preferred orientations of cubic, hexagonal, and trigonal crystals are discussed; results expected from theory seem consistent with experiments for $LaAlO_3$, α quartz, and ice.—*from* Author's abstract

Irving, E. *See* Roy, J. L. 04010

04100 **Isacks, Bryan; Molnar, Peter.** Mantle earthquake mechanisms and the sinking of the lithosphere: Nature, v. 223, no. 5211, p. 1121-1124, illus., 1969.

A comprehensive and worldwide survey of focal mechanism solutions supports the view that deep and intermediate earthquakes occur within downgoing slabs of lithosphere in response to stresses within the plates. A model is given which predicts a correlation between the respective depth variations of focal mechanism and seismicity. Regions where down-dip extensional stress predominates are characterized by notable gaps in seismicity as a function of depth or an absence of deep earthquakes; regions where down-dip compressional stress predominates are apparently continuous. Downgoing slabs may exert a pull on the surface portions of the plates, and as downgoing slabs "hit bottom" beneath the lithosphere, the downward pull may be significantly decreased. Pull of descending slabs may be an important contribution to driving forces of global tectonics.—DBV

04039 **Iyer, H. M.; Pakiser, L. C.; Stuart, D. J.; Warren, D. H.** Project Early Rise—Seismic probing of the upper mantle: Jour. Geophys. Research, v. 74, no. 17, p. 4409-4441, illus., tables, 1969.

Project Early Rise, in which 38 chemical explosions were fired in Lake Superior in July 1968, is described and results are presented. One model (NCER 1) of P-wave velocity structure under North America shows rapid change in gradient at about 480 km depth, corresponding to the 20° discontinuity. Model (NCER 4) shows sharp discontinuity in velocity gradient at 440 km. NCER 1 is an average representation of upper mantle P-wave velocity for the North American continent and NCER 4 for the continental area west and northwest of Lake Superior. The rapid change in velocity at 400-500 km corresponds closely with experimentally predicted depth of the olivine-spinel transition zone. Composition of upper mantle olivine seems to be about $Fo_{88}Fa_{12}$, and temperatures within the transition zone probably lie in the 1,200-1,500°C range.—DBV

Jackman, H. W. *See* Ehrlinger, H. P., 3d. 03949

Jackson, Dallas B. *See* Zohdy, Adel A. R. 03829

03715 **Jackson, David D.** Elastic relaxation model for seismic wave attenuation in the Earth: Physics Earth and Planetary Interiors, v. 2, no. 1, p. 30-34, illus., table, 1969.

Love wave amplitude data are satisfied by an Earth model in which the intrinsic internal friction (Q^{-1}) at each depth is taken to be due to a single thermally activated relaxation mechanism. In this model intrinsic Q^{-1} is completely specified by a simple function of frequency, temperature, and pressure. This model is in better agreement with observed behavior of solids than previous models and requires fewer arbitrary parameters to satisfy seismic data.—Author's abstract

Jackson, E. D. *See* Kistler, R. W. 03898

Jackson, G. D. *See* Donaldson, J. A. 04201

Jackson, G. D. *See* Donaldson, J. A. 04202

03745 **Jackson, Joe L.** Geologic studies at Arbuckle Dam, Murray County, Oklahoma: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 79-99, illus., 1968 [1969].

The dam is on the north flank of the Arbuckle uplift where late Pennsylvanian conglomerate on the right abutment abuts and unconformably overlaps complexly folded and faulted older Paleozoic shale and limestone in the foundation area across the valley and the left abutment in the Reagan fault zone and Mill Creek syncline. Probably the principal factor behind the designer's apprehension concerning the soundness of the interpretive geologic data was the engineer's reluctance to accept the premise that even though the site was in an area of intense folding and faulting, the foundation would be competent and essentially watertight without special treatment. This lack of faith resulted in a considerable underrun of their estimated grouting requirements and a substantially higher grouting cost than otherwise would have been required.—HRC

03825 **Jacobs, Alan M.** Pleistocene niche glaciers and proto-cirques, Cataract Creek valley, Tobacco Root Mountains, Montana, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 103-114, illus., table, 1969.

Two moraines were deposited by Pleistocene niche or slab glaciers that emanated from poorly developed cirques along the valley sides rather than by valley glaciers that emanated from well-formed cirques at elevations of >9000 feet. Niche or slab glaciers were formed in hollows at elevations of <8000 feet because hollows were hemmed in and orographically influenced by valley glaciers on the south and east and by the main mountain divide on the north and west. The two valley glaciers generated a locally cold microclimate in the hollows, which were well-situated for accumulation of snow drifting across the nearby divide. The fortuitous position of these hollows during late Pleistocene resulted in incipient glacier formation at elevations lower than would be expected.—*from* Author's abstract

04144 **Jacoby, W. R.** Gravity variations and precipitation—Discussion [of paper by A. M. Luiz, 1969]: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 801, 1969.

The data given by Luiz (ibid., no. 1, p. 190-192) are not explained by his proposed theory, as four points are shown to be incorrectly stated. —HRC

Jaffe, Howard W. *See* Robinson, Peter. 03860

04195 **Jain, Raj K.; Hall, John W.** A contribution to the early Tertiary fossil record of the Salviniaceae: Am. Jour. Botany, v. 56, no. 5, p. 527-539, illus., table, 1969.

Megaspores and massulae of *Azolla*, *Azollopsis*, and *Salvinia* are recorded from the Paleocene and Eocene of Montana and the Dakotas. Three new species of *Azolla* are described and two are redescribed. The columnella of the floating apparatus of the megaspore apparatuses of *Azolla* appears to be a phylogenetic localization of the perispore around the megaspore. A new section (*Kremastospora*) is erected within *Azolla*. Megaspores and massulae of *Salvinia preauriculata* are associated with leaf remains. The megaspores and massulae of the fossil forms are much smaller than those of the living forms. The similar size of the megaspores and massulae of the fossil species suggests a less specialized condition than in the living species where these two structures differ greatly in size. —*from* Authors' abstract

03958 **Jamieson, B. G.** Construction of natural-phase diagrams from the melting relations of basalts: Geol. Soc. London Proc., no. 1651, p. 208-211, illus., discussion, 1969.

Projection of reduced analytical data into planes within the system enables pseudoternary phase diagrams to be constructed. An example is presented in a projection of reduced tholeiitic analyses, mainly of melted Hawaiian basalts, from, or towards, the olivine composition point into the plane R_2O_3-XO.ZO_2-YO.ZO_2. Analyses of some 20 porphyritic Mauna Loa and Kilauea lavas have been projected. The crystallization order—olivine, clinopyroxene, plagioclase, orthopyroxene for the Kilauea lavas, and

orthopyroxene as second solid phase after olivine for all Mauna Loa lavas—is clearly shown by the phase diagrams, leading to conclusions compatible with currently accepted genetic theories of the importance of crystal fractionation, especially of olivine, as a mechanism causing magmatic diversification and the lack of any direct relation between Kilauea and Mauna Loa magmas near surface. —GDC

04170 **Jeffery, P. M.; Hagen, P. J.** Negative muons and the isotopic composition of the rare gases in the Earth's atmosphere: Nature, v. 223, no. 5212, p. 1253, table, 1969.

It is suggested that for a single value of time integrated negative muon flux, the muon capture reaction can account for several isotopic anomalies observed in the atmospheric rare gases. In particular it provides the following: neon with low Ne-21/Ne-22 ratio; krypton with Kr-86/Kr-84 ratio higher than atmospheric Kr; xenon with an isotopic pattern that is a maximum at Xe-132 and decreases with mass. —DBV

Jessen, F. W. *See* Fertl, Walter. 04168

Jhaveri, D. P. *See* Liu, S. C. 04114

04073 **Jindrich, Vladimir.** Recent carbonate sedimentation by tidal channels in the Lower Florida Keys: Jour. Sed. Petrology, v. 39, no. 2, p. 531-553, illus., table, 1969.

Bluefish Channel, north of Key West is incised in a thick Recent carbonate bank on Pleistocene bedrock. The dominant sediments are *Halimeda*, foraminifera, mollusks, and fragments derived from the bedrock. The source area lies all along the channel; sediment mixing results in textural inversions and characteristically negatively-skewed channel sands. A sorting-grain size plot shows a sinusoidal trend similar to that of a beach environment. The best sorted sediment is mature medium calcarenite, a mixture of four constituents in almost equal proportions. Some calcarenites deposited at the tidal delta, adjacent to the channel, show the initial stages of penecontemporaneous, submarine cementation by chemically precipitated aragonite crystals. Hydrodynamically, the channel is in the upper-flow regime.—*from* Author's abstract

Joensuu, O. *See* Fisher, David E. 04056

Joensuu, Olva. *See* Boström, Kurt. 03899

Johnsen, S. J. *See* Dansgaard, W. 03678

03892 **Johnson, Allen H.** Stratigraphy and paleoenvironment of the Dinosaur Canyon Member of the Moenave Formation, southern Navajo and Hopi Indian Reservations, Arizona, *in* Geology and natural history of the Grand Canyon region—Four Corners Geol. Soc., 5th Field Conf., 1969: [Durango, Colo.] Four Corners Geol. Soc., p. 181-183, illus., 1969.

Two main lithologic types, well-sorted and poorly sorted sandstone, are defined for the Dinosaur Canyon Member of the Moenave Formation. Well-sorted, very fine-grained sandstones are concentrated near Kachina Point and intertongue northward with more poorly-sorted sandstone. The poorly-sorted sandstone is probably of fluvial origin, and was deposited on a surface that sloped towards the northwest. Cross-bedding in the poorly-sorted sandstone indicates a predominantly sediment-transport pattern to the northwest. All evidence points to a southern source for the Dinosaur Canyon Member. Data indicate a paleoslope like that of the Chinle Formation rather than that of the overlying Kayenta Formation. The well-sorted sandstone is probably of eolian origin.—KAF

03826 **Johnson, G. Leonard.** Morphology of the Eurasian Arctic basin: Polar Rec., v. 14, no. 92, p. 619-628, illus., 1969.

Features of the Eurasian side of the Arctic Basin described in this report include the continental margin (the widest known on Earth) with its major epi-continental seas

—the Barents, Kara, and Laptev; the Barents Abyssal Plain between the shelf and the Mid-Oceanic Ridge; the Pole Abyssal Plain between the Mid-Oceanic and Lomonosov Ridges; and the Mid-Oceanic, Lomonosov, and Alpha Ridges. Abyssal sedimentation is discussed; dating of cores on Alpha Ridge (Hunkins and Kutschale, 1965) indicates a rate of 1.5 to 3 mm per 1,000 yr. The rate should be lower for abyssal plains. Tectonic activity is believed to be a continuing feature of the Mid-Oceanic Ridge, Lomonosov Ridge is postulated to be a fragment of the Greenland shelf left by sea-floor spreading, and Alpha Ridge may be an extinct axis of sea-floor spreading. —VSN

04035 **Johnson, Kenneth G.; Friedman, Gerald M.** The Tully clastic correlatives (Upper Devonian) of New York State—A model for recognition of alluvial, dune(?), tidal, nearshore (bar and lagoon), and offshore sedimentary environments in a tectonic delta complex: Jour. Sed. Petrology, v. 39, no. 2, p. 451-485, illus., tables, 1969.

Four lithosomes are identified: A, the thinned eastward extension into the study area of the Tully Limestone; B, above A and coextensive with the eastern extension of the Genesee Shale, very dark fissile shale grading eastward into shaly siltstone; C, a clastic wedge which envelops A and B, of siltstone and fine-grained sandstone with much sedimentary structure preserved; and D, red and green siltstone and mudstone with immature sandstone interbedded. Tully sedimentation occurred during a transgression; terrigenous material was trapped east of a submarine topographic high, thus permitting carbonate deposition in an otherwise clastic basinal area. Landward migration of the strandline resulted in more widespread estuarine conditions. The rising sea level caused alluviation of fine-grained sediments in entering streams, resulting in greater quantities during Tully time than before or after.—*from* Authors' abstract

03770 **Johnson, Kenneth S.** Oklahoma mineral raw materials for chemical industry (exclusive of petroleum and coal): Oklahoma Geology Notes, v. 29, no. 4, p. 100-106, illus., 1969.

Oklahoma has vast reserves of certain high-purity minerals suitable as raw material for various chemical industries. Major deposits of limestone, dolomite, and silica sand are in the south-central and eastern parts, whereas gypsum and salt are widespread in the west; these resources are currently being worked on a limited scale, chiefly for nonchemical products. However, ample room for major expansion into chemical fields is available, with potential sources for caustic soda, soda ash, chlorine, sulfur, sulfuric acid, lime, sodium silicate, and other chemical products. Oil, natural gas, and water are plentiful in most areas, and bituminous coal is abundant in the eastern section. Most mineral deposits are near railroads.—*from* Author's introduction

Johnson, L. *See* Smith, S. W. 04007

03675 **Johnson, Stanley S.; Palmer, C. Sweet.** Magnetic and gravity surveys of Albemarle and Fluvanna Counties, Virginia: Virginia Div. Mineral Resources Rept. Inv. 20, 10 p., illus., 1969.

Albemarle and Fluvanna Counties are largely in the Piedmont province, with the exception of western Albemarle County which is in the Blue Ridge province. The area is underlain by metamorphosed volcanic, plutonic, and sedimentary rocks of Precambrian to early Paleozoic age and by sedimentary and intrusive igneous rocks of Triassic age. Correlations were generally found to exist between the contoured magnetic and gravity data and recent geologic maps. The unit having the most distinctive magnetic properties is the Catoctin Formation, predominantly a thick series of metamorphosed basaltic lava flows. Gravity values generally decrease westward from eastern Fluvanna County in the central Piedmont to the eastern Blue Ridge in western Albemarle County.—Authors' abstract

03668 **Johnston, F. J.** Geology of the western Minnitaki Lake area, District of Kenora: Ontario Dept. Mines Geol. Rept. 75, 28 p., illus., tables, geol. map, 1969.

In this area of about 73 sq mi, the Precambrian bedrock consists of alternating northeast-trending belts of metavolcanics and metasediments, unknown age relationships, locally intruded by quartz and feldspar bodies, and in the southern part by granitic rocks forming the northern limit of a batholithic mass. Little Vermilion Fault separates the metavolcanics from the metasediments, with contacts elsewhere appearing conformable, except in the northeast part of Pickerel Arm. The Precambrian rocks are mantled by extensive deposits of clay, sand and gravel of Pleistocene age, and by swamp and vegetal deposits of Recent age. There are a number of gold showings, mainly in quartz veins filling fractures in the metavolcanics and periphyry intrusions. Iron formations cited seem uneconomic, although one deposit south of Minnitaki Lake contains a substantial tonnage of low-grade magnetite.—*from* Author's abstract

04270 **Johnston, G. H.** Dykes on permafrost, Kelsey Generating Station, Manitoba [with French abs.], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 139-157, illus., tables, 1969.

Under two small sand dikes, constructed on perennially frozen ground at the Kelsey Generating Station on the Nelson River, permafrost occurred in scattered islands or patches of variable thickness and size. Approximate analysis indicated a significant 50-year period of thawing beneath the dike-water interface and complete thawing under the reservoir, and ground settlements of as much as six feet were to be expected. Since 1958, a distinct pattern of thawing and settlement each year has been observed, at rates greater in summer than winter. The change in rate is directly connected with changes in water temperature or rate of heat flow into the ground. —*from* Author's abstract

Johnston, H. S. *See* Eyring, H. 04261

03915 **Jonas, John J.; Müller, Fritz.** Deformation of ice under high internal shear stresses, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 963-967, illus.; discussion, p. 967-968, 1969.

By means of transparent plastic dies, cylindrical samples of single crystal and polycrystalline ice were extruded into rods of one quarter the original cross-section area. The deformation was carried out at -5°C and a mean strain rate of about $10^{-5}s^{-1}$. With the aid of polarized light, the formation of cracks and the occurrence of dynamic recrystallization were studied. The experiments of Steinemann, and more recent results in metals suggest that, during such plastic flow, two types of dynamic recrystallization are involved. At low strain rates, the recrystallization is periodic, leading to rapid increases in strain rate at constant applied stress; at higher strain rates, the recrystallization is continuous and the strain rate is constant. The possibility that dynamic recrystallization of the periodic type is associated with glacier surges is discussed.—Authors' abstract

Jones, Austin E. *See* Boucher, Gary. 04052

03739 **Jones, Benjamin L.** Simplified pumping sampler for suspended sediment, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C212-C214, illus., 1969.

A simplified pumping sampler was developed for the collection of suspended-sediment samples from streams. The sampler has a capacity of 20 containers, and the interval between samples can be varied from 2 minutes to several hundred hours. The sampler consists of a pump, electronic controls, and a bottling mechanism. The low initial cost, small size, and ease of installation of the device make it suitable for incorporation into present data-collection programs.—Author's abstract

03818 **Jones, Blair F.; Vandenburgh, A. S.; Truesdell, A. H.; Rettig, S. L.** Interstitial brines in playa sediments, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 253-262, illus., tables, 1969.

At Abert Lake, Oregon, interstitial solute concentrations increased with depth to values as much as five times greater than the lake, except where springs indicate significant ground-water input. These interstitial fluids, when compared with local runoff, impoundments, or spring waters, commonly have a distinctive ionic composition which sometimes cannot be explained by either simple mixing of surface and subsurface inflow or by evaporative concentration. The Na^+/Cl^- ratios are indicative of total CO_2 in solution and the effects of organic decay in surficial sediments. These ratios, coupled with data on silica and bulk density, show that higher $P_{carbon\ dioxide}$ accompanying decay promotes silicate dissolution and hydrogen ion exchange, stripping alkalis from sediments which had preferentially adsorbed K^+ when entering the lake. The silica is resorbed on the dissolution products.—*from* Authors' summary

Jones, Blair F. *See* Truesdell, Alfred H. 03865

Jones, D. L. *See* Fahrig, W. F. 04162

04272 **Journaux, M. A.** Phénomènes périglaciaires dans le nord de l'Alaska et du Yukon [with English abs.]: Assoc. Géographes Français Bull. 369, p. 337-350, illus., 1969.

The author presents many pictures of landscapes and exposes some problems of periglacial morphology: ice in soil, and in particular ice wedges and pingoes; oriented lakes and their evolution; frost boils of clay or silt, etc. —*from* Author's English abstract

Judd, Frank. *See* Dalquest, Walter W. 03809

Julian, Bruce R. *See* Anderson, Don L. 03907

04334 **Kaliser, Bruce N.** Slips showing: Utah Geol. and Mineralog. Survey Quart. Rev., v. 3, no. 1, p. 3, illus., 1969.

Beginning with the Vaiont Dam (Italy) tragedy, the importance of landslides in dam failures is reviewed. The U.S. Bureau of Reclamation is now making landslide studies part of their periodic review. In the Pine View Reservoir in Ogden Canyon, slope failures have gone almost unnoticed. The zone of failure coincides with an outcrop of weak metasediments of the Precambrian Mineral Fork formation. All slopes along reservoirs should be considered potential hazards. —ESL

04090 **Kanehira, Kelichiro.** Sulphide ores from the Coronation mine, Saskatchewan, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 79-135, illus., tables, 1969.

Pyrite, pyrrhotite, chalcopyrite, sphalerite, and magnetite are the main minerals of the ores. Ilmenite is not uncommon, gold and arsenopyrite are rare, and cubanite occurs occasionally as exsolution lamellae in chalcopyrite. Marcasite is found in minute veinlets of a later mineralization. The mineral assemblages appear consistent with formation temperature of 500°C. The mineral assemblages and structures of ores jointly suggest that the present state of the ore deposits was mostly formed during a period of regional metamorphism. Minor veins composed of chalcopyrite, tetrahedrite, pyrite, and calcite are found in the mine. The veins formed by a later mineralization. —*from* Author's abstract

04315 **Kaplar, Chester W.** Laboratory determination of dynamic moduli of frozen soils and of ice: U.S. Army Materiel Command Cold Regions Research and Eng. Lab. Research Rept. 163, 45 p., illus., table, 1969.

Results of laboratory investigations of frozen soils and ice to determine the elastic moduli by the sonic method are presented. Vibration tests were performed on a total of 56 specimens representing 8 soil types, 2 blended soils, natural peat, laboratory-frozen ice, and natural lake ice at temperatures from ±32F to -10F. Elastic wave velocities were computed for each material. Dynamic moduli of elasticity of frozen soils were found to increase with decrease in temperature. Coarse granular soils gave the highest values and clays the lowest. Average values of Poisson's ratio for all soils

did not conform to any logical pattern. The dynamic moduli of elasticity of ice showed only slight dependence on temperature, and test values were more consistent than those of soils. Natural lake ice was least temperature dependent and gave most consistent results. —*from* Author's abstract

04248 **Karrow, P. F.** Stratigraphic studies in the Toronto Pleistocene [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 4-16, illus., tables, 1969.

In the Pleistocene of the Toronto area York Till, Illinoian, is overlain by fossiliferous, river or lake sediments of the Don Formation, Sangamon(?). Next is the fossiliferous Scarborough Formation, presumed early Wisconsin; these deltaic deposits indicate a high-level lake draining down the Hudson Valley related to an ice dam in the St. Lawrence. Channel sands and deeply eroded valleys indicate return of drainage to the St. Lawrence before the area was overridden by early Wisconsin ice which deposited the Sunnybrook Till. During a middle Wisconsin nonglacial interval, the Thorncliffe Formation was deposited; C-14 dates on peat support correlation with the Port Talbot Interstade. A major late Wisconsin advance deposited the Leaside Till. Postglacial Lake Iroquois sediments, dated 12,000 y.b.p., mark the end of the glacial sequence. —*from* Author's abstract

04328 **Karttunen, J. O.; Harmon, W. R.** Determination of uranium in ores and in solution using a portable non-dispersive X-ray spectrograph: Spectrochim. Acta, v. 24B, no. 6, p. 301-311, illus., tables, 1969.

The portable nondispersive X-ray fluorescence instrument developed was tested for its application to the determination of uranium in solution, in simulated ores, and in naturally occurring ores. This portable X-ray fluorescence instrument is composed of a small radioisotope source for excitation (cobalt-57), a compact proportional counter for detection, a miniaturized electronic package, a recorder for data presentation, and is easily contained in a one-cubic-ft volume. Using this portable instrument, uranium in solution was determined with a relative error of ±2.4 percent, and in simulated ores with a relative error of ±4.0 percent. The natural gamma radiation of uranium provides another analytical technique whereby with this instrument uranium in ores was determined with a relative error of ±2.0 percent. —Authors' abstract

03982 **Kasira, Iyadural.** Low-cycle fatigue damage in structures subjected to earthquake excitation [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4646B, 1969.

Katsura, Takashi. *See* Walker, James L. 04126

03967 **Kaufman, A.** The Th-232 concentration of surface ocean water: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 717-724, illus., tables, 1969.

Previous workers have reported Th-232 concentrations in surface sea water ranging from 0.3 to 0.6μ g per 1000 liters. Whereas these estimates were based on the analysis of single samples, the present work is based on a composite of 24 analyses of water collected from widely spaced parts of the ocean. A careful interpretation of the alpha spectrometer data indicates that the true concentration is less than 0.07μ g per 1000 liters.—Author's abstract

Kawai, Naoto. *See* Merrill, R. T. 04017

03671 **Keech, C. F.; Svoboda, G. R.** Water levels in observation wells in Nebraska, 1968: Nebraska Water Survey Paper 24, 69 p., illus., table, 1969.

Except for a few, the water-level measurements in this report are made in the fall after the close of the irrigation season. Sixty of the 93 counties ended the year 1968 with average water levels lower than in the fall of 1967. Rising water levels are accounted for in counties where surface water is diverted from streams for irrigation, or where recharge from greater-than-normal precipitation balanced discharge. All counties with significant declines have heavily developed ground water. Water levels

and departures from assumed normal and from previous fall are tabulated by county.—MCM

04167 **Keller, W. D.; Hanson, Robert F.** Hydrothermal argillation of volcanic pipes in limestone in Mexico [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 17, no. 1, p. 9-12, illus., 1969.

Kaolin deposits of hydrothermal origin have been described from extrusive igneous parent rocks. Recently, evidence from three localities near Jasso-Calera, north of Mexico City, near Coacoyula, Guerrero, and Sombrerete, Zacatecas, confirms an intrusive mode of occurrence for hydrothermally kaolinized agglomerate and tuff within limestone host rock. Contacts of deposits with limestone show concentration of iron-rich minerals such as red to brown oxides and/or nontronite, but less commonly irregular development of grossularite, and bands or pockets of endellite. Silica gossans indicate that hypogene altering solutions were active into the current geomorphic cycle. Kaolinite at the center of the clay body and endellite at border zones are interpreted as originating from in situ alteration of solid rock and deposition from ambient solutions respectively.—*from* Authors' abstract

04020 **Kellerhals, Peter; Murray, J. W.** Tidal flats at Boundary Bay, Fraser River delta, British Columbia: Bull. Canadian Petroleum Geology, v. 17, no. 1, p. 67-91, illus., tables, 1969.

In Boundary Bay sandy tidal flats extend 2.5 mi seaward in four sedimentologic-hydrologic divisions, each with distinct drainage and sedimentary structure plus diagnostic flora and fauna. A salt marsh with meandering tidal creeks has poorly stratified, silty and sandy peat, dense halophytes seaward, and terrestrial plants landward; it progrades in western part of the bay over high flats which, with irregular, incomplete drainage, are covered in winter by sand but in summer by blue-green algal mats, producing a varve-like stratification. In contrast, intermediate flats have a well-developed dendritic drainage, no vegetation, and fine to medium-grained sand being reworked by shifting channels and fauna. Low flats are cut by deeper, more stable channels, in which high velocities produce dunes, eel grass flanks the sides, and shell beds are in lag deposits. Average rate of sedimentation for the last 4350 yr is 0.42 mm/yr.—*from* Authors' abstract

03672 **Kelley, Vincent C.** Albuquerque, its mountains, valley, water, and volcanoes: New Mexico Bur. Mines and Mineral Resources Scenic Trips Geol. Past, no. 9, 101 p., illus., tables, 1969.

This guidebook differs from previous ones in containing sections on special geologic aspects, including arroyos, fans, and mesas; Rio Grande trough and floodplain; water supplies; volcanoes; and the Sandia Mts. Five trip logs are given.—ESL

04293 **Kemp, K. G.** A recent log evaluation technique—Synergetic systems [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 95, 1968 [1969].

Kennedy, George C. *See* Williams, David W. 04027

Kennedy, V. C. *See* Malcolm, R. L. 04274

03753 **Kent, B. H.** Methods of storing and retrieving core-log data on coal-bearing rocks in southwestern Pennsylvania, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C166-C173, illus., 1969.

Core-log data on Upper Pennsylvanian and Lower Permian coal-bearing strata in southwestern Pennsylvania are being stored and retrieved by computer methods by the U.S. Geological Survey. In the format, a numerical code is applied to the named stratigraphic units and to all subordinate rock units in the lithologic column; data are then punched on cards. Both the code and the card-file system are expandable, to accomodate new data or further subdivision of rock units. Retrieval by specifying coded contacts instantly provides, for example, data on thickness of intervals and constituent coal, sandstone, and limestone, and on cumulative thicknesses. Utiliza-

tion of this wide range of selective data, available on demand, is illustrated by a coal-to-coal isopach map series. Comparisons between isopach maps in this series show recurring thickness patterns of possible environmental significance.—*from* Author's abstract

Kesler, Stephen E. *See* Collins, Earl M. 03689

Khan, Mohammad Asadullah. *See* Moberly, Ralph, Jr. 04256

04001 **Khattab, Mohamed Mamdouh M.** Gravity and magnetic surveys of the Grouse Creek Mountains and the Raft River Mountains area and vicinity, Utah and Idaho [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4720B, 1969.

03941 **Kigoshi, Kunihiko; Aizawa, Hiroko; Suzuki, Nobuko.** Gakushuin natural radiocarbon measurements VII: Radiocarbon, v. 11, no. 2, p. 295-326, 1969.

This list continues Gakushuin VI (1967) employing the same instruments and techniques. Geologic samples are from Japan, Australia, and Papua and New Guinea; archeologic samples are from Canada, Oklahoma, and Washington.—MCM

03945 **Kim, Stephen M.; Ruch, R. R.** Illinois State Geological Survey radiocarbon dates I: Radiocarbon, v. 11, no. 2, p. 394-395, 1969.

The radiocarbon dating laboratory of the Illinois State Geological Survey has been established to satisfy a growing need for radiocarbon dates for an active Pleistocene research program. Interlaboratory check samples are from Australia and Wisconsin, and geologic samples are from Illinois.—MCM

04037 **Kinsman, David J. J.** Interpretation of Sr^{+2} concentrations in carbonate minerals and rocks: Jour. Sed. Petrology, v. 39, no. 2, p. 486-508, illus., tables, 1969.

Distribution coefficient data for the coprecipitation of Sr^{+2} with aragonite and calcite at low temperatures enable the Sr^{+2} concentrations of carbonate minerals and rocks to be interpreted in terms of the Sr/Ca ratio of the solution and the temperature. Sea water and other waters have been analyzed to provide the necessary solution data. Predicted Sr^{+2} concentrations of aragonite from sea water are 8290 ± 850 ppm for the Bahamas, about 17 percent lower than actually found. Organic complexing of cations may account for the differences. Aragonite from Bahaman coral and algae shows that the Sr^{+2} uptake seems to be affected only slightly by biochemical fractionation, in comparison with most molluscan aragonites. The Sr^{+2} concentrations of diagenetically altered limestones are demonstrated to be of potential value in indicating the mechanism of diagenesis. —HRC

Kirk, J. Norman. *See* Dellwig, Louis Field. 04335

04176 **Kiss, Klara; Page, Harold T.** Electron microscopic identification of single crystals of wairakite, a rare component in clays [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 17, no. 1, p. 31-35, illus., tables, 1969.

Crystallites of the finest fraction of a clay mineral from Rosamund, Calif., which account for over 50 percent of the total weight, are identified as wairakite single crystals of 0.1-1μ size. High-magnification electron microscopy revealed flat, almost perfectly square-shaped lamellae, which consist of superimposed layers of approximately <50 A thickness. Electron diffraction patterns from a selected single crystal proved that the basal plane of the crystallite aligned perpendicular to the electron beam is the (111) plane. It is suggested on the basis of the present study and the report of previous investigators that the pseudocubic wairakite crystals cleave along their (111) and ($\bar{1}$11) planes. The indices of high order reflections, unpublished or previously reported as uncertain, are determined. —Authors' abstract

03898 **Kistler, R. W.; Obradovich, J. D.; Jackson, E. D.** Isotopic ages of rocks and minerals from the Stillwater Complex, Montana: Jour. Geophys. Research, v. 74, no. 12, p. 3226-3237, illus., tables, 1969.

The K-Ar ages of two whole-rock specimens from the chilled border phase of the Stillwater complex are 3.2 ± 0.2 b.y., and 2.3 ± 0.2 b.y. Rb-Sr and K-Ar ages of micas and K-Ar ages of plagioclase vary between 2.7 and 2.0 b.y. Mica and plagioclase ages may record the time of crystallization or that of the last thermal metamorphism of the complex. Ages of 7.1 and 8.4 b.y. obtained by routine K-Ar dating of augite and bronzite show that both pyroxenes contain excess radiogenic Ar. Increment heating argon extractions on these pyroxenes demonstrate that Ar is held in two positions in the minerals. It is concluded that the major component, as well as possibly all the excess radiogenic Ar, in the Stillwater pyroxenes is held at the interfaces between host crystals and exsolution lamellas.—*from* Authors' abstract

04290 **Kittrick, J. A.** Quantitative evaluation of the strong-force model for expansion and contraction of vermiculite: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 222-225, table, 1969.

The model used considers expanding forces arising from hydration of positive interlayer ions, negative charge sites, and vermiculite surface. These are opposed by the electrostatic contracting force between positive interlayer ions and negative charge sites. Thermodynamic estimates based upon this model are in qualitative agreement with water sorption by Li, Na, K, Rb, and Cs vermiculites, and are in quantitative agreement with Na vermiculite. Agreement was dependent upon strong hydration of the negative charge sites. The model and the thermodynamic estimates suggest a mechanism for fixation of ions by vermiculite. —Editor's brief

04210 **Klassen, R. W.** Quaternary stratigraphy and radiocarbon chronology in southwestern Manitoba: Canada Geol. Survey Paper 69-27, 19 p., illus., table, 1969.

Quaternary stratigraphic succession in southwestern Manitoba includes glacial and nonglacial sediments indicative of three glacial and three nonglacial intervals. Oldest nonglacial deposit appears to be early Pleistocene, later deposits late Pleistocene. Deposition of oldest named till was followed by deposition of nonglacial 'Roaring River Clay' that may correlate with early Wisconsin St. Pierre and Missinabi beds in eastern Canada or with Sangamon interglacial deposits of midwestern United States. A finite radiocarbon date from sediments between later and youngest tills suggests sediments correlate in part with those of the Port Talbot interstade, Lake Erie region, eastern Canada. Late glacial and recent sediments within Assiniboine River valley yielded C-14 ages that permit correlation of postglacial valley development with events in Lake Agassiz Basin. —*from* Author's abstract

Klein, Cornelis, Jr. *See* Robinson, Peter. 03860

03806 **Klement, William, Jr.** Representation for compressional velocity data near the lambda transition in limestones and marbles: Jour. Geophys. Research, v. 74, no. 15, p. 3940-3941, illus., 1969.

It is shown that most of Wang's (1966) data on compressional velocity for calcite and limestones may be simply represented near the transition pressure p as V_p varies as $A(p_{lambda}-p)^{beta}$ for $p < p_{lambda}$ and V_p varies as $A\theta(p-p_{lambda})^{beta}$ for $p > p_{lambda}$ where $\theta = 1/2$, $\beta = 1/3$, and A is a constant for a given material.—KAF

03900 **Klement, William, Jr.** High-low quartz inversion—Relations among shear compliances and piezoelectric strain coefficients: Jour. Geophys. Research, v. 74, no. 12, p. 3287-3290, illus., 1969.

Linear relations over appreciable ranges of temperature near the inversion are found among the critically evaluated data for the shear compliances s_{44} and s_{66}, for s_{44} or s_{66} and s_{14}[4] and for the piezoelectric strain coefficients d_{11}[4] and d_{14}. It is suggested that d_{11} and d_{14} vary as $(T_{lambda}-T)^{0.11\beta}$ on heating to the transition temperature T_{lambda} These relations are also applied for neutron-bombarded samples and are discussed with respect to some current microscopic knowledge for quartz.—Author's abstract

Klemic, Harry. *See* Gair, Jacob E. 03721

04286 **Kline, J. R.; Foss, J. E.; Brar, S. S.** Lanthanum and scandium distribution in three glacial soils of western Wisconsin: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 287-291, illus., tables, 1969.

Neutron activation analysis was used to measure La and Sc in three soils developed from loess-capped glacial till. Lanthanum content ranged from 18.1 to 37.1 ppm, and Sc contents ranged from 5.1 to 10.9 ppm. The amounts of Sc were associated with both clay and free iron in these soils. Relationships between these variables and La were less strong. The evidence suggests that Sc may move in soil profiles predominantly in association with clays. Lanthanum moves both in association with clays and as a free ion. —Editor's brief

Knight, C. J. *See* Fairbairn, H. W. 03871

Knight, Curtis A. *See* Toksöz, M. Nafi. 03832

03878 **Kornik, Leslie J.** An aeromagnetic study of the Moak Lake—Setting Lake structure in northern Manitoba: Canadian Jour. Earth Sci., v. 6, no. 3, p. 373-381, illus., 1969.

An integrated aeromagnetic-geologic interpretation of the Moak Lake-Setting Lake structure, a distinctive magnetic feature which contains the Manitoba nickel belt, is presented. This structure is separated, on the basis of aeromagnetic and geologic data, into eastern and western areas. A main fault zone, which is mapped in part and is also an aeromagnetic lineament, separates the two areas. It is deduced that the western area of the Moak Lake-Setting Lake structure was involved in the Hudsonian orogeny only. The eastern area is interpreted to have been initially involved in the Kenoran(?) orogeny, which produced the characteristic charnockite and pyroxene granulite rocks, and was then reinvolved in the dynamic effects of the Hudsonian orogeny.—*from* Author's abstract

Kortüm, K. *See* Perkampus, H. H. 04230

Kovach, Robert L. *See* Anderson, Don L. 04083

04108 **Kovach, Robert L.; Robinson, Russell.** Upper mantle structure in the Basin and Range province, western North America, from the apparent velocities of S waves: Seismol. Soc. America Bull., v. 59, no. 4, p. 1653-1665, illus., tables, 1969.

The variation of shear velocity with depth in the upper mantle for the Basin and Range province of western North America has been studied with direct measurements of $dT/d\Delta$ for S waves in the distance range $14° < \Delta < 40°$. Three orthogonal components of digital data were used and onset times were determined using the product of the horizontal radial and vertical components of motion and particle motion diagrams. A linear LRSM array in Arizona was used for the measurement of $sT/d\Delta$. An S-wave velocity distribution is derived, compatible with P-wave velocity models for the same region. The derived model consists of a thin lid zone of shear velocity 4.5 kmps overlying a low-velocity zone and a change in velocity gradient at a depth of 160 km. Two regions of high-velocity gradient are located at depths beginning at 360 km and 620 km. —Authors' abstract

04336 **Kover, Allan N.** Status of sidelooking radar imagery for earth resources studies: Tulsa Geol. Soc. Digest, v. 36, p. 43-45, illus., revised 1968 [1969]; originally published 1968.

The paper, originally presented at the Symposium on remote sensing of environment, 5th, 1968, Proc., p. 781-785, 1968, has been revised to bring it up to date as of March 1969. *See* Abstracts of North American Geology for July 1969. —MCM

03760 **Koyanagi, Robert Y.** Hawaiian seismic events during 1967, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C79-C82, illus., 1969.

Several tens of thousands of earthquakes were recorded in Hawaii during 1967; of those, 551 with a magnitude of from 2.0 to 4.6 were located. Of the 140 earthquakes felt by residents, 11 were felt over the entire island.—Author's abstract

03864 **Kramer, James R.** Subsurface brines and mineral equilibria, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 37-50, illus., tables, 1969.

Approximately 2,500 analyses of brines are classified as to rock type, and data are subjected to factor analysis to determine possible mineral equilibria; these conclusions are used to calculate ion products which are compared with equilibrium values. Most waters, regardless of rock type, are basically Na, Ca chloride (ion exchange?) with a secondary inverse relationship to HCO_3 ($CaCO_3$ saturation); most waters show SO_4 to be an independent variable; Ca and Mg show a stronger inverse correlation to HCO_3 in dolomite than in other rock types; and Ca shows a stronger correlation with Mg in dolomite than limestone (suggesting Ba, Sr-CO_3 equilibrium). Conclusions from a smaller population of more complete data confirm the above and suggest in addition an equilibrium involving K-Mg-H-Si.—*from* Author's summary

03694 **Kretz, Ralph.** On the spatial distribution of crystals in rocks: Lithos, v. 2, no. 1, p. 39-65, illus., tables, 1969.

The distribution of crystals and crystal boundaries in a thin-section of pyroxene-scapolite-sphene granulite from Quebec are examined in detail. Although slight variations in mineral proportion exist across the thin-section, a certain portion of the section may be regarded as homogeneous. Within this portion, crystals of pyroxene, scapolite, and sphene are randomly distributed, and sphene crystals are not preferentially associated with pyroxene or scapolite crystals. Hence each site of mineral nucleation was apparently located at random and with complete disregard for other crystals in the immediate vicinity.—Author's abstract

03691 **Krieger, R. A.; Cushman, R. V.; Thomas, N. O.** Water in Kentucky: Kentucky Geol. Survey, ser. 10, Spec. Pub. 16, 51 p., illus., tables, 1969.

This report, written for the layman, explains the water cycle, water quality in general and specifically for Kentucky, how Kentuckians use water, Kentucky's water problems and how they can be solved. It also answers questions on measuring precipitation and evaporation, streamflow, ground water, and water quality; discusses water laws; and lists publications on water in Kentucky.—MCM

Krogh, T. E. *See* Brooks, C. 03835

04151 **Kumarapeli, P. S.** St. Dominique fault—A new interpretation: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 775-780, illus., 1969.

The St. Dominique fault has been customarily regarded as a thrust fault because of its close spatial association with the thrust faults of Logan's Line. It also is, however, closely associated in space with the normal faults in the St. Lawrence Valley. Moreover, evidence from the shape of the fault-trace in plan and from possible cognate structures favor the interpretation that the St. Dominique fault is a normal fault. This fault, as well as other normal faults in the St. Lawrence Valley, seems to have formed during the Mesozoic Era. —Author's abstract

Kuo, C. S. *See* Condie, Kent C. 03701

03884 **Kustra, C. R.** Port Arthur district, *in* Annual report of Resident Geologists' Section, Geological Branch, 1968, Pt. 1: Ontario Dept. Mines Misc. Paper 23, p. 33-46, illus., 1969.

Exploration activity was widespread in the Port Arthur mining division due to discovery of radioactivity associated with strong faults in granitic rocks, in addition to the polymetallic ores. New maps and literature on the district are listed; geology and mineralization of five properties are described.—ESL

Labeyrie, J. *See* Delibrias, G. 03942

Lacoss, R. T. *See* Capon, J. 03974

Laguros, Joakim G. *See* Papadopoulos, George T. 03816

04128 **Lajtai, E. Z.** Strength of discontinuous rocks in direct shear [with French abs.]: Géotechnique, v. 19, no. 2, p. 218-233, illus., 1969.

The strength of discontinuous rocks under direct shear loading is examined. In a direct shear test, a homogeneous and isotropic rock may fail by three mechanisms: failure in tension, in shear, and in ultimate strength. Strength parameters include tensile and fundamental shear strengths, angle of internal friction, angle of friction at ultimate strength, and the normal stress on plane of enforced shear. The direct shear strength of planes of weakness, orientated in the plane of enforced shear, is derived from two sources: strength of solid rock where no separation exists and joint friction along separated parts of the shear surface. Maximum shear strength develops only if solid strength and joint friction are mobilized simultaneously, that is at the same deformation. —*from* Author's abstract

04179 **Lajtai, Emery Zoltan.** Stratigraphy of the University subway, Toronto, Canada [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 17-23, illus., tables, 1969.

The area studied includes the entire University route and those parts of the Bloor-Danforth line that were excavated before the summer of 1963; information collected is augmented by boreholes penetrating below the lower limit of excavation. Pleistocene glacial and interglacial deposits rest on Ordovician bedrock, the Dundas Formation. The oldest glacial deposits here are a clayey till and associated varved clays, assigned to the Illinoisan. Above these are the Sangamon interglacial sands of the Don Formation and the cool-climate Scarborough beds. This sequence is overlain by Wisconsin glacial deposits, Sunnybrook Drift, overlain by a thick deposit of till west of St. George Street. Surficial deposits were laid down along the beach of Lake Iroquois. —*from* Author's abstract

03993 **Lambert, Paul Wayne.** Quaternary stratigraphy of the Albuquerque area, New Mexico [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4713B, 1969.

03712 **Lamonds, A. G.; Hines, Marion S.; Plebuch, Raymond O.** Water resources of Randolph and Lawrence Counties, Arkansas: U.S. Geol. Survey Water-Supply Paper 1879-B, p. B1-B45, illus., tables, 1969.

Water use in Randolph and Lawrence Counties averages almost 27 mgd; quantities sufficient for any foreseeable use are available from wells in the Coastal Plain and streams in the Interior Highlands. Most water is from wells that tap Quaternary alluvial deposits in the Coastal Plain and commonly yield 1,000 gpm; however, the water is often unsuitable for many uses without treatment. Possibilities for further sources are in the Tertiary Wilcox Group and Cretaceous Nacatoch Sand in the southeastern section, but these have not been explored in the report area. Wells in the Interior Highlands generally are less than 200 feet deep and yield 10 gpm; water is very hard and susceptible to local bacterial contamination. It may be possible to obtain greater amounts from two unexplored formations, the Roubidoux and the Gunter Sandstone Member of the Van Buren Formation.—*from* Authors' abstract

Landis, E. R. *See* Ratté, James C. 03723

04026 **Lange, A. L.; Westphal, W. H.** Microearthquakes near the Geysers, Sonoma County, California: Jour. Geophys. Research, v. 74, no. 17, p. 4377-4378, illus., 1969.

In 120 hours of recording in October 1968, 19 small earthquakes were found on the fault system associated with Geysers steam zone in Sonoma County, California. These earthquakes, as distinguished from steam-generated seismic noise, provide further evidence of the genetic relationship between the two phenomena and suggest that the mapping of microearthquakes could be used in the exploration for geothermal power. —Authors' abstract

03741 **Langmuir, Donald.** Geochemistry of iron in a coastal-plain ground water of the Camden, New Jersey, area, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C224-C235, illus., tables, 1969.

In the Camden area pH of ground water in Cretaceous formations ranges from 5-6 in outcrop area to 8 several miles downdip. Iron is present as dissolved Fe^{+2} and $FeOH^{+1}$ and as suspended ferric oxyhydroxides in which are probably a mixture of amorphous material and goethite with small amounts of hematite. In the outcrop area concentration of dissolved ferrous or mg/l suspended ferric species is <0.5 per l in unpolluted waters; downdip ferrous and ferric irons increase to about 6-7 and 6-11 mg/l, respectively; farther downdip at pH's>6.5 both forms decrease to <0.5 mg/l. Ferrous species decrease may reflect increase in stability of suspended amorphous material owing to aging, with adsorption of ferrous iron by oxyhydroxides and partial conversion of amorphous phase to goethite; decrease in suspended ferric species is by cation adsorption, aging, coagulation, and settling.—*from* Author's abstract

03776 **Larochelle, A.** Comments on paper by McElhinny, Briden, Jones, and Brock, 'Geological and geophysical implications of paleomagnetic results from Africa' [1968]: Rev. Geophysics, v. 7, no. 3, p. 663, table, 1969.

McElhinny and others (ibid., v. 6, no. 3, p. 201-238, 1968; Abstracts of North American Geology, September 1968) in questioning reliability of paleomagnetic results reported for a number of Precambrian rock units of the Canadian shield, indicated that the site mean direction should be the lowest sampling level acceptable for paleomagnetic studies. Larochelle summarizes paleomagnetic directions of the Abitibi and Sudbury dike swarms from his 1966 and 1967 papers which could have been quoted by McElhinny *et al.* This comment does not support the theory that the Precambrian Canadian and African polar-wander curves(?) can be 'successfully superposed.' —MCM

Lazrus, A. L. *See* Cadle, R. D. 03727

04301 **Lebourg, M.· Campbell, A. T., Jr.; Witterholt, E. J.** Detection of deep formation "damage": Tulsa Geol. Soc. Digest, v. 36, p. 73-88, illus., 1968 [1969].

The characteristics of deep formation "damage" and low permeability appear quite similar on a normal formation test. A method for positive identification between them is described, taking advantage of a deviation from the Horner assumption in his theory of superposition. Under drill-stem test conditions, where flow rate is very low, an expanding dominant transient is created by afterflow extending the radius of investigation during the shut-in period. An extended shut-in will thus allow an inspection of permeability at a great distance from the well. Field results are given to support this new evaluation technique. Mathematical support for the technique is presented in the appendix. —*from* Authors' abstract

03766 **Lee, Donald E.; VanLoenen, Richard E.** Phengitic micas from the Cambrian Prospect Mountain Quartzite of eastern Nevada, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C45-C48, illus., tables, 1969.

Four samples of Cambrian Prospect Mountain Quartzite collected from the southern and central Snake Range of eastern Nevada contain phengitic micas of very similar composition, indicating that these quartzites recrystallized under conditions of low-grade greenschist facies metamorphism.—Authors' abstract

03757 **Lee, Fitzhugh T.; Nichols, Thomas C., Jr.; Abel, John F., Jr.** Some relations between stress, geologic structure, and underground excavation in a metamorphic rock mass west of Denver, Colorado, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C127-C132, illus., 1969.

Field testing of a solid-inclusion probe that determines three-dimensional stress changes at one location in a borehole in a rock mass began in December 1966. Since then, 19 probes have been installed underground at two locations in the Front Range west of Denver; stability of probes and reliability of measurements have been good.

Evaluation of results shows that major geologic structures are major influences upon redistribution of stresses around an actively excavated opening. Mining operations and preexcavation rock stresses also influence redistribution of stresses, but usually not in a manner explained by a simple elastic analysis. Anomalously high stresses are associated with local or regional geologic structures. Results suggest that high stresses are produced by activation, through excavation, of strain energy that may have been stored in the rock by Laramide tectonic forces.—*from* Authors' abstract

Lee, G. Fred. *See* Wentz, Dennis A. 04013

Lee, G. Fred. *See* Wentz, Dennis A. 04015

Lee, G. Fred. *See* Delfino, Joseph J. 04016

03734 **Lee, P. J.** FORTRAN IV programs for canonical correlation and canonical trend-surface analysis: Kansas Geol. Survey Computer Contr. 32, 46 p., illus., 1969.

Multiple correlation techniques have been applied frequently in geology. A typical application might relate a bulk property of a rock to a series of mineralogical or textural properties. However, geologists may make two or more sets of measurements on a single specimen. The technique of relating one set of variables to another set of variables is called canonical correlation. A technique similar to trend analysis except that the trend determined is not the trend of any particular variable, but is the common trend of a set of variables, may be called canonical trend-surface analysis. Under canonical correlation, computational procedures, limitations, and comparison with other statistical techniques are discussed. The discussion on canonical trend surfaces uses as an example the Permian system in western Kansas and eastern Colorado. —ESL

04061 **Lené, Gene W.; Owen, Donald E.** Grain orientation in a Berea Sandstone channel at South Amherst, Ohio: Jour. Sed. Petrology, v. 39, no. 2, p. 737-743, illus., table, 1969.

A particulate study of the orientation of elongate quartz grains in horizontal and vertical planes was performed on a well-documented, sand-filled stream channel preserved in the Berea Sandstone, a protoquartzite, in Buckeye quarry at South Amherst, northern Ohio. A mean compass orientation of 263° (standard deviation = 18.8°) with a mean magnitude of 17.7 percent was obtained for the imbricated, horizontally oriented grains. This direction is in good agreement with paleocurrent directions inferred from channel trend and crossbedding measurements. Paleocurrent studies of sandstones based on grain orientations have much broader application than those based on megascopic directional sedimentary structures. —Authors' abstract

Lerman, J. C. *See* Vogel, J. C. 03943

03856 **Lewis, John F.** Composition, physical properties, and origin of sodic anorthosites from the ejected plutonic blocks of the Soufrière volcano, St. Vincent, West Indies: Contr. Mineralogy and Petrology, v. 21, no. 3, p. 272-294, illus., tables, 1969.

Anorthite can be precipitated from subalkaline magmas under certain conditions and does not require the postulation of special magmas or of contamination. It is apparent that factors other than normative feldspar composition of the magma determine the composition of the feldspar precipitated. Evidence from experimental work on synthetic systems indicates that an increase in both hydrostatic pressure and water vapor pressure will influence the plagioclase composition but it is not possible to evaluate these effects fully at the present time. The occurrence of anorthite is interpreted as evidence of extensive crystal accumulation at depth from fractionating basic magmas in the circumoceanic calc-alkaline zones.—*from* Author's abstract

Lewis, Richard Q., Sr. *See* Thaden, Robert E. 04192

Libby, W. G. *See* Sinclair, A. J. 04182

Licari, G. R. *See* Cloud, P. E., Jr. 03684

Lipschutz, M. E. *See* Balsiger, H. 03851

04003 **Lissey, Allan.** Surficial mapping of groundwater flow systems with application to the Oak River Basin, Manitoba [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4734B, 1969.

04114 **Liu, S. C.; Jhaveri, D. P.** Spectral and correlation analysis of ground-motion accelerograms: Seismol. Soc. America Bull., v. 59, no. 4, p. 1517-1534, illus., 1969.

The autocorrelation function and the power-spectral density function of 12 strong-motion earthquakes and three underground nuclear explosion accelerograms are obtained using a digital computer. The physical implications of the results and their application in modeling ground accelerations are studied. Simulations by the spectral approach, using filtered stationary processes, and simulations by the correlation approach, using linear, particularly autoregressive processes, are discussed in some detail. —Author's abstract

04115 **Liu, Shih-Chi.** Autocorrelation and power spectral density function of the Parkfield earthquake of June 27, 1966: Seismol. Soc. America Bull., v. 59, no. 4, p. 1475-1493, illus., tables, 1969.

The autocorrelation and power spectral density functions of a total of 14 strong-motion accelerograms of the Parkfield earthquake are obtained. When the ground motions are treated as random phenomena, these functions are found appropriate to be used as statistical characterization functions for the ground motions. Spectral simulation procedure is employed to determine the modal contributions of the motion and the ground characteristic damping and frequency at each station. The results can be used to construct reasonable single- or two-degree-of-freedom linear filters for the generation of a stationary stochastic model for the ground motion. The implications and engineering significance of the basic results are also discussed in some detail. —Author's abstract

03897 **Lliboutry, Louis A.** Contribution à la théorie des ondes glaciaires [with English abs.], *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 943-952, illus., table; discussion, p. 952-953, 1969.

Glacier surges may result from the fact that two values of the sliding velocity correspond to a single value of the friction. As a rule, for increasing sliding velocities, the friction goes through a maximum and next through a minimum; thus, for one value of the friction three values of the velocity, two stable ones and an unstable one, can exist. Since the derivative of the friction with respect to the sliding velocity may become negative, the coefficients c_o and D_o in the pertubation equation may become infinite (their ratio remaining finite) and next negative. By this means, when a flood wave runs down a glacier an area with a negative diffusion coefficient may appear. Then the wave profile is altered; it vanishes at the upper part of this area and swells beyond measure at the lower one.—*from* Author's abstract

03660 **Loeblich, Alfred R., Jr.; Tappan, Helen.** Acritarch excystment and surface ultrastructure with descriptions of some Ordovician taxa [with Spanish abs.]: Rev. Española Micropaleontología, v. 1, no. 1, p. 45-57, illus., 1969.

Methods of excystment of acritarchs, organic-walled microfossils of uncertain affinities, include simple partial rupture, median splitting, development of a pylome and operculum, or an epityche (outfolded flap formed by an elongate submarginal slit in the vesicle wall). The pseudopylome, a nonfunctional antapical thickening, may be mistaken for the pylome. Characters of excystment, surface ultrastructure, and distinctive types of processes are the bases for these new taxa: *Asketopalla formulosa*, n.gen., n.sp.; *Polyancistrodorus columbariferus*, n.gen., n.sp.; *Veryhachium irroratum*, n.sp., all from the Middle Ordovician Bromide Formation, Murray County, Okla., and also a new genus and combination from the Tremadocian of Morocco.—*from* Authors' abstract

03931 **Löken, O. H.** Evidence of surges on the Barnes Ice Cap, Baffin Island, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 899-900, illus.; discussion, p. 900-901, 1969.

The morphology of the Barnes Ice Cap is studied on the basis of detailed topographic maps. Two anomalous areas characterized by an apparent excess of mass at lower elevations and a similar deficit at higher altitudes are identified. Local surges affecting these two parts of the ice cap could have caused this mass distribution. The moraine patterns adjacent to the ice cap show that the ice margin in the two areas has recently advanced in distinct contrast to the general retreat in adjacent areas. —Author's abstract

03746 **Love, Colin L.; Donner, Robert L.** Computer determination of seismic refraction velocities and depths: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 101-107, illus., 1968 [1969].

A computer program has been developed to reduce the time required to interpret data from shallow refraction seismic studies. Using the least squares method the computer determines the best fit for both a two- and a three-layer case and prints out velocities, depths, and a time-distance graph. An engineering geologist accepts or rejects the computer analysis of the data based on the appearance of anomalies on the time-distance graph and his knowledge of the geology and topography of the area. —Authors' abstract

03888 **Lovell, H. L.** Kirkland Lake district, *in* Annual report of Resident Geologists' Section, Geological Branch, 1968, Pt. 3: Ontario Dept. Mines Misc. Paper 25, p. 1-11, illus., 1969.

The discovery of Jurassic pyrope-bearing kimberlite in a gold mine created activity in staking, but generally exploration activity was moderate, mostly for high-grade silver deposits. Mining activities are reviewed, and new maps and literature published in 1968 are listed.—ESL

03944 **Lowdon, J. A.** Isotopic fractionation in corn: Radiocarbon, v. 11, no. 2, p. 391-393, tables, 1969.

This study was started in 1965 because of the discrepancy observed between dates obtained from wood charcoal and charred corn samples collected from the same archeologic sites. In both cases the wood charcoal gave the more acceptable archeologic age, accepting the assumption made by the collector that the different materials dated were living contemporaneously. Isotopic fractionation was thought to be a plausible explanation for the cause of the younger corn dates; an analysis of modern corn samples corroborated this assumption by giving a correction factor that placed the charred corn and wood charcoal dates in close agreement.—MCM

Lowell, Brent H. *See* McNellis, Jesse M. 03799

03751 **Lucchitta, Ivo; M'Gonigle, John W.; Schleicher, David.** The possibilities for using data centers in geologic mapping, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C155-C157, 1969.

A data center similar in concept to that being developed for lunar exploration may increase the efficiency, thoroughness, and speed of geologic mapping. Basically, use of a center involves a fieldman or men radioing observations to a team of other geologists and technicians, who promptly record and compile the field data. The elaborateness of the data center depends on mapping requirements. Although equipment and procedures are more complex than those used in conventional geologic mapping, the use of a data center should (1) encourage speedy development of a comprehensive and regional perspective, (2) utilize people economically in functions commensurate with their training, (3) generally make for more efficient use of time, and (4) thus commonly reduce overall costs for certain field projects.—Authors' abstract

03752 **Lucchitta, Ivo; M'Gonigle, John W.; Schleicher, David; Hait, Mortimer H.** Use of a data center in geologic mapping—A test report, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C158-C165, illus., 1969.

A field test was held to study geologic exploration done in conjunction with a data-reduction center conceptually similar to that proposed for lunar exploration. A geologist in the field radioed his observations to a van, where they were recorded by three other geologists. Objectives were to test: a guide for describing geologic data, forms for systematically recording and retrieving the data, and procedures for effective communication. The test suggests that a data center can effectively record and organize geologic data. Use of a description guide focused and organized descriptions. The recording forms tested did not provide for recording interpretations or making corrections, but they did systematize the raw field data.—Authors' abstract

04145 **Luiz, A. M.** Gravity variations and precipitation—Reply [to discussion of 1969 paper by W. R. Jacoby, 1969]: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 802, 1969.

"The comments presented by W. R. Jacoby on my note are correct, but the conclusions are wrong. Unfortunately, some mistakes have not been corrected in the revision of my note. The principal purpose of my note was to suggest a possible correlation between the hours of rainfall and the hours of maximum and minimum values of gravity." The data (ibid., v. 6, p. 190-192) suggest such a correlation, but an analysis of the precipitation data from other areas would be necessary to demonstrate its validity. A connection may be shown by a serious study of the role of gravity in the process of nucleation and growth of droplets. —HRC

04036 **Lumsden, David N.; Pelletier, Bernard R.** Petrology of the Grimsby Sandstone (Lower Silurian) of Ontario and New York: Jour. Sed. Petrology, v. 39, no. 2, p. 521-530, illus., tables, 1969.

The Grimsby Sandstone, on the south shore of Lake Ontario, is a hematitic quartz sandstone with subordinate graywacke, siltstone, and shale. Red color dominates with some green-gray mottles and layers. Samples from 15 measured sections showed increasing mean grain size from Clappison Corners, Ontario (0.0364 mm), east to Lockport, N.Y. (0.1051 mm), and from there decreasing east to Fulton, N.Y. (0.0652 mm). This corresponds directly to thickening of the formation from 5 feet 4 inches at Clappison Corners to 24 feet at Lockport, thence a thinning to 7 feet 4 inches at Fulton. Deltaic subaerial to nearshore environment of deposition is indicated by the gross lens shape of the formation, its red coloration, variable clastic lithology, current and interference ripple marks, shale pebble conglomerates, swash and wash marks, and mud cracks. —*from* Authors' abstract

03747 **Lutzen, Edwin E.; Williams, James H.** Missouri's approach to engineering geology in urban areas: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 109-121, illus., 1968 [1969].

After consulting with civil engineers and land use planners, it was decided to produce maps with text designed to illustrate and delineate engineering geology problems on 7-1/2 minute quadrangle bases. The first completed map is the Maxville Quadrangle in Jefferson County. The map shows surface units whose boundaries may transgress geological and pedological boundaries. Major surface unit boundaries, based primarily on engineering characteristics of the bedrock formations, outline engineering geology units. Overburden soils frequently exhibit variations in engineering characteristics that will influence urban development. Consequently, subunits were developed and were established for these variations. The field and laboratory criteria used in developing the map include basic soil mechanics, pedological, geophysical, geological, and groundwater data.—*from* Authors' abstract

04104 **Luykendyk, Bruce P.; Engel, Celeste G.** Petrological,magnetic and chemical properties of basalt dredged from an abyssal hill in the northeast Pacific: Nature, v. 223, no. 5210, p. 1049-1050, tables, 1969.

The petrological, magnetic, and chemical properties of a basalt dredged from depths of 4,400o4,300 m off a 100-m high linear scarp on the side of an abyssal hill in the northeastern Pacific are consistent with the hypothesis that the crust under the oceans is a distinct tholeiitic basalt. —DBV

Lynch, J. J. *See* Smith, A. Y. 04310

Maberry, John O. *See* Osterwald, Frank W. 03686

04002 **MacCracken, Michael Calvin.** Ice age theory analysis by computer model simulation [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4720B-4721B, 1969.

03805 **Macdonald, Gordon Andrew.** Petrology of the basalt cores from Midway atoll: U.S. Geol. Survey Prof. Paper 680-B, p. B1-B10, illus., tables, 1969.

Basalts beneath the limestone cap of Midway atoll are much altered due to long saturation with sea water. They appear to be tholeiitic, but pebbles in overlying gravels indicate a former cap of alkalic lavas. Subaerial soil zones are present, and textures indicate the lavas were erupted either subaerially or in very shallow water. Their present position is due to subsidence of more than 1,260 feet.—GAM

MacDonald, Harold C. *See* Dellwig, Louis Field. 04335

03924 **Mack, Harry.** Nature of short-period P-wave signal variations at LASA: Jour. Geophys. Research, v. 74, no. 12, p. 3161-3170, illus., tables, 1969.

Seismic events recorded by individual subarrays at LASA were Fourier-analyzed. For any particular subarray the amplitude spectrum was divided by the average spectrum for all 21 subarrays. This process produced similar spectra for events with the same epicenter, suggesting that the average amplitude spectrum is that of a "primary" signal and that each subarray has a distance and azimuth-dependent transfer function that operates on this primary signal to produce the amplitude spectrum of the subarray. The time-domain transfer function associated with a subarray consists of a series of time-delayed delta functions, each associated with an amplitude coefficient. The interference of these multiple arrivals with one another causes the recorded signal variations between subarrays. It is suggested that deep crustal relief causes multipathing of a P-wave incident from below.—*from* Author's abstract

Mackenzie, Fred T. *See* Billings, Gale K. 03852

04260 **Maddocks, Rosalie F.** Revision of Recent Bairdiidae (Ostracoda): U.S. Natl. Mus. Bull. 295, 126 p., illus., tables, 1969.

The ostracode form genus "*Bairdia*" in the broad sense has been applied to over 600 smooth-carapaced species of Ordovician to Holocene age, although there is general agreement that *Bairdia* s.s. should be restricted to the upper Paleozoic. In this study, 54 Holocene species of Bairdiidae, including 21 new species, and additional subspecies and variants, are identified and described by a combination of soft-part and carapace morphology. The subfamily Bairdiinae includes *Neonesidea*, n.gen., *Paranesidea*, n.gen., *Triebelina*, and *Bairdoppilata* with subgenera *Bairdoppilata* and *Glyptobairdia*. Bythocyprinidae, n. subfam., includes *Bythocypris*, *Zabythocypris*, n.gen., and *Anchistrocheles*. The taxa are presumed to be equally appropriate for any post-Paleozoic bairdiids. —VMJ

04221 **Magara, Kinji.** Upward and downward migrations of fluids in the subsurface: Bull. Canadian Petroleum Geology, v. 17, no. 1, p. 20-46, illus., 1969.

Normally most compaction current in shales, after deposition, would move upward because of downward decreasing porosity and permeability; but, where underlain by a thick permeable sandstone bed, some should move downward in shales close to sandstone. Boundary-surface level or thickness of fluid-movement zones is related to minimum permeability, viscosity of water and pressure distribution. These zones can

be determined in a schematic example of very rapidly deposited shale-sandstone sequence. Although smaller, the downward compaction current could be the more important, for the role of cap rock to [hydrocarbon] reservoirs. To estimate its amount, thickness of the downward zone is related to porosity decrease during compaction. Schematic calculations indicate the main downward current to occur in early stages of rapid sedimentation. —*from* Author's abstract

04274 **Malcolm, R. L.; Kennedy, V. C.** Rate of cation exchange on clay minerals as determined by specific-ion electrode techniques: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 247-253, illus., tables, 1969.

By the use of sodium and potassium specific-ion electrodes, the Ba-K, Mg-K, Ca-K, Ba-Na, Mg-Na, and Ca-Na exchange rates for kaolinite, illite, and montmorillonite were rapid (within a few seconds). The Ba-K exchange on several vermiculites exhibited two rates of exchange: a rapid rate and a slow diffusion controlled exchange rate. Ba-Na exchange on Poole vermiculite exhibited the two exchange rates, but Ca-K, Mg-K, Ca-Na, and Mg-Na exchange rates were rapid for all vermiculites. —Editor's brief

03704 **Mangelsdorf, P. C., Jr.; Wilson, T. R. S.; Daniell, Ellen.** Potassium enrichments in interstitial waters of recent marine sediments: Science, v. 165, no. 3889, p. 171-174, illus., 1969.

Potassium enrichments in marine sediments have been reported which would imply a rate of diffusion of potassium into the oceans much larger than any of the known rates of addition or removal by other mechanisms. Experiments with mixtures of seawater and clay suggest that spurious enrichments can be produced if sediment samples are allowed to warm up before the pore water is expressed.—Authors' abstract

04004 **Manghnani, Murli H.** Elastic constants of single-crystal rutile under pressures of 7.5 kilobars: Jour. Geophys. Research, v. 74, no. 17, p. 4317-4328, illus., tables, 1969.

The elastic constants of single-crystal rutile, measured to 7.5 kb at 25°C and to 100°C at 1 bar by ultrasonic interferometry, are found to vary linearly with pressure and temperature within experimental error. The pressure and temperature derivatives of the elastic constants are given. The value of (dK_s/dP), where K_s is the isotropic adiabatic bulk modulus derived from the Voigt-Reus-Hill approximation, is 6.76. The value of $(d\mu_\mu/dP)$, where μ_μ is the isotropic shear modulus, is low (0.78). The values for (dK_s/dT) AND $(d\mu_\mu/dT)$ are -0.41 and -0.27 kb per deg, respectively. The pressure and temperature dependence of isotropic velocities are given. The reported shock wave and X-ray data for rutile are discussed in the light of the ultrasonic equation of state. —*from* Author's abstract

03866 **Manheim, F. T.; Bischoff, J. L.** Geochemistry of pore waters from the Shell Oil Company drill holes on the continental slope of the northern Gulf of Mexico, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 63-82, illus., tables, 1969.

Six holes were drilled in water 600-3,000 feet deep and penetrated up to 1,000 feet of Pliocene-Recent clayey sediments. Samples from near diapiric structures showed systematic increases of pore-water salinity with depth. Anomalous concentrations of K and Br indicate that at least one plug contains late-stage evaporite minerals. Salinities approaching halite saturation were observed. Samples from holes away from diapiric structures showed little change in pore-water chemistry, except for loss of SO_4 and other variations attributable to early-stage diagenetic reactions with enclosing sediments. Thus, increased salt concentrations in even shallow sediments from this part of the Gulf appear to provide an indicator of salt masses at depth.—*from* Authors' summary

03994 **Marchand, Denis Eugene.** Chemical weathering, soil formation, and geobotanical correlations in a portion of the White Mountains, Mono and Inyo Counties, California [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4713B-4714B, 1969.

Marshall, Neil F. *See* Shepard, Francis P. 03706

Marshall, Neil F. *See* Piper, David J. W. 04069

Martin, R. *See* Davies, J. L. 03664

Mason, Brian. *See* Faust, George T. 03702

04185 **Mathews, W. H.; McTaggart, K. C.** The Hope landslide, British Columbia [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 65-76, illus., tables, 1969.

On January 9, 1965, a landslide of about 130 million metric tons of rock buried British Columbia [highway] 3 to a maximum depth of 250 feet. The slide incorporated slightly schistose metavolcanics with intrusive sheets of felsite dipping nearly parallel to the 30° slope of the mountain side. One prehistoric major landslide and an incipient slide have been recognized on this same slope. Geologic factors contributing include: weakness in or near the felsite sheets, schistosity and jointing parallel to the surface, and alteration of joint filling. Two earthquakes of magnitudes 3.1 and 3.2 were associated with snowslides and the large landslide, and are considered to have been a major factor in launching them. Coarse rocky debris originating from the slope 2,200 to 3,600 feet above its foot, slid in surges and came to rest on the valley floor in a series of concentric ridges. —*from* Authors' abstract

Mathieu, Guy. *See* vanDonk, Jan. 03726

Matthews, Vincent, 3d. *See* Salotti, Charles A. 04175

03854 **McAuliffe, Clayton.** Determination of dissolved hydrocarbons in subsurface brines, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 225-233, illus., tables, 1969.

Hydrocarbons dissolved in water can be determined by several analytical procedures. The method selected should depend upon the hydrocarbons of interest and the sensitivity required. These methods provide techniques that can be used as an aid in petroleum exploration, and provide information to help answer questions concerning petroleum origin, migration, and accumulation. Proper precautions must be taken to minimize hydrocarbon loss during sample collection, storage, and analysis. The solubility of hydrocarbons in water varies as much as 5-6 orders of magnitude, depending upon the hydrocarbon type and molecular weight within a homologous series. The concentration of dissolved hydrocarbons in subsurface brines varies widely from brine to brine. Marked variations also occur in the relative concentrations of the individual hydrocarbons dissolved.—Author's summary

03735 **McCammon, Richard B.** FORTRAN IV program for nonlinear estimation: Kansas Geol. Survey Computer Contr. 34, 20 p., illus., tables, 1969.

NONLIN is a FORTRAN IV computer program for estimating parameters in algebraic nonlinear simultaneous equations. The program is designed for problems in which the number of observations equals or exceeds the number of parameters to be estimated. Starting from initial estimates, a modified Gauss-Newton procedure is used to obtain an improved set of parameter values. The process is continued until a set of best estimates has been obtained. A number of options in the program offer wide flexibility in handling a variety of nonlinear problems. Numerical examples are given for dissecting a bimodal distribution into normal components and estimating the porosity in vuggy carbonates.—*from* Author's abstract

McCamy, Keith. *See* Haubrich, Richard A. 03775

04325 **McCoy, Roger M.** Drainage network analysis with K-band radar imagery: Geog. Rev., v. 59, no. 4, p. 491-512, 639, 1969.

Recent studies show radar imagery to be a strong tool for drainage basin analysis. An investigation of the relationship between stream parameters derived from 1:24,000 topographic maps and those derived from corresponding areas of K-band radar

imagery indicates that a definite consistency exists between the two modes of terrain display. Thus stream measurements made from radar imagery can be used to predict drainage parameters equivalent to a 1:24,000 scale topographic map analysis. Measurements of drainage composition included area, number of streams, total length of streams, drainage density, and basin perimeter. Image interpretation methods and a comparison of image and map drainage networks are also discussed. —Author's abstract

03963 **McDonald, B. C.** Surficial geology of La Patrie-Sherbrooke area, Quebec, including Eaton River watershed: Canada Geol. Survey Paper 67-52, 21 p., illus., geol. map, 1969.

Exposures along major rivers reveal the presence of three till sheets, probably all of Wisconsin age, separated by lake sediments. Nonglacial episodes antedating the last glacial phase are widespread and are recorded by lake sediments in thirty sections within the map-area. Ice-flow during the last glacial phase was from the northwest. No evidence exists to support the concept of late glacial flow of ice into Quebec from New England. Till fabrics and indicators show that ice flowed from east-northeast during at least part of the penultimate glacial phase. Ice-front positions during final deglaciation are well marked and indicate northwestward retreat of an active ice-front. Glacial lakes were dammed by the ice and were widespread during deglaciation. Principal areas of interest for groundwater potential are areas of ice-front sedimentation and drainage diversion.—Author's abstract

McGinley, J., Jr. *See* Smith, S. W. 04007

McKee, Bates. *See* Diery, Hassan D. 03674

03725 **McKelvey, V. E.; Tracey, J. I., Jr.; Stoertz, George E.; Vedder, John G.** Subsea mineral resources and problems related to their development: U.S. Geol. Survey Circ. 619, 26 p., illus., 1969.

Statements made by United States representatives before the Economic and Technical Subcommittee of the U.N. Committee on Peaceful Uses of the Seabed and Ocean Floor beyond the Limits of National Jurisdiction, 1969, are on the following topics: subsea physiographic provinces and their mineral potential; progress in exploration and exploitation of subsea petroleum resources and its implications for development beyond the limits of national jurisdiction; progress in exploration and exploitation of hard minerals from the seabed; potential ill effects of subsea mineral exploitation and measures to prevent them; topographic and geologic mapping of the sea bottom; origin, incidence, effects, and means of prevention and control of oil-well blowouts; and implications of geologic and economic factors to seabed resource allocation, development, and management.—MCM

McLane, J. E. *See* Greenland, L. Paul. 03750

04314 **McMillian, Leslie G.; Hauser, Victor L.** Field evaluation of potential pollution from ground-water recharge: Water Well Jour., v. 23, no. 8, p. 22-23, 43, illus., 1969.

The Ogallala aquifer serves a large area in the western interior United States. Increasing demands in the High Plains of Texas make underground storage in this aquifer desirable. A promising and immediate source of recharge water is runoff collected in thousands of playas, conceivably through irrigation wells. The degree and extent of possible pollution from pesticides, nitrates, and other chemicals are unknown. Tests with a portable pump system near Amarillo showed that nitrate movement was essentially identical to that of recharge water, and its concentration could be reduced only by dilution with native water; DDT would be a health hazard only in the recharge well, since it adsorbs strongly to aquifer material, but long-term behavior of possible alteration products is unknown. Equipment and field procedures of this project can and should be used to evaluate the pollution potential of critical chemicals. —GDC

McMullen, C. C. *See* Schwarcz, H. P. 03838

McMullen, R. M. *See* SenGupta, B. K. 03869

McMurtrey, R. G. *See* Reed, T. E. 04308

McNellis, Jesse M. *See* Ropes, Leverett H. 03716

McNellis, Jesse M. *See* Morgan, Charles O. 03717

03718 **McNellis, Jesse M.; Morgan, Charles O.** Modified Piper diagrams by the digital computer: Kansas Geol. Survey Spec. Distrib. Pub. 45, 36 p., illus., tables, 1969.

Piper diagrams, used as aids in interpreting quality-of-water data, are produced accurately and efficiently by a digital computer. The computer produces the two triangular cation and anion diagrams and a square-grid modification of the original diamond-shaped diagram. Seven diagrams comprise the output from a quality-of-water data group. Three diagrams are square and the points plotted represent program-assigned sample identification numbers, aquifer identification numbers, and average position by aquifer number, respectively. Four diagrams are triangles to include cation and anion representations with sample and aquifer identification numbers.—Authors' abstract

03799 **McNellis, Jesse M.; Morgan, Charles O.; Lowell, Brent H.** Computer-produced tables, maps, and diagrams as tools in the interpretation of brine data from southeastern Kansas (U.S.A.), *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 303-324, illus., tables, 1969.

The applicability of computer-oriented techniques to assist in the interpretation of brine data is demonstrated by the use of six programs on data from two example areas. These programs include a data tabling routine; routines for producing Stiff, Piper, and Ropes diagrams; programs for calculating ionic ratios; and programs for plotting maps of chemical data. The examples illustrate: (1) the range in water quality and contamination of potable water by brines in Stafford, Pratt, and Barber Counties, and (2) the change in water quality in the Arbuckle Group from southeast to south-central Kansas.—Authors' summary

04305 **McNitt, James R.** Geothermal resources—AAPG distinguished lecture [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 93-94, 1968 [1969].

04136 **McPherson, H. J.; Gardner, J. S.** The development of glacial landforms in the vicinity of the Saskatchewan Glacier: Canadian Alpine Jour., v. 52, p. 90-96, illus., 1969.

Canadian Rocky Mountain glaciers have receded fairly rapidly in the past century. In once glaciated areas, now vegetated, large but low cross-valley ridges of till have been erroneously interpreted as end moraines. Those near the snout of well-documented Saskatchewan Glacier were not formed as it retreated from its Neoglaciation limit, but are older landforms which emerged from beneath the ice. This finding has important implications for traditional glacial geomorphic interpretations which would result in incorrect conclusions regarding the manner of ice retreat in a valley glacier. Flutings superimposed on the "highs" are believed to have formed subglacially during ice retreat, hypothetically from the squeezing of unfrozen till into linear low pressure zones at the base of the glacier, in positions corresponding to splaying crevasses near its terminus which create an uneven distribution of ice weight.—GDC

McTaggart, K. C. *See* Mathews, W. H. 04185

Medlin, J. H. *See* Ondrick, C. W. 04231

03995 **Medlin, Jack Harold.** Comparative petrology of two igneous complexes in the South Carolina Piedmont [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4715B, 1969.

03927 **Meier, Mark F.** Seminar on the causes and mechanics of glacier surges, St. Hilaire, Canada, September 10-11, 1968—A summary, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 987-989, 1969.

Regrettably, few authors were able to present detailed and pertinent quantitative results of measurements on surging glaciers. The few quantitative observations presented were very interesting. A large number of papers presented what might be called reconnaissance observations. A third type of paper deduced the existence of surges in the geological past, in areas where surging glaciers no longer exist. As for theory, three main problems need to be explained: what triggers surges, the origin of the high speeds in some, and how can the high speed be maintained as surface slope and thickness decrease? Large-scale implications, such as sea level changes and climatic changes, are outlined. Five long-sought answers are recorded, and four outstanding questions remain from the seminar.—HRC

03940 **Meier, Mark F.; Post, Austin.** What are glacier surges?, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 807-816, illus.; discussion, p. 816-817, 1969.

The 204 known surging glaciers in western North America surge repeatedly and probably uniformly (from 15 to more than 100 years). Glaciers of all sizes and shapes can surge, and no unusual "ice dams" or bedrock constrictions are evident. Surges occur in many different climatic, tectonic, and ecologic environments, but only in certain limited areas (mainly in Alaska). Three types are defined: (1) large to moderate-sized with large displacement and fast flow; (2) large to moderate sized with moderate displacement and flow rates, and (3) small glaciers with small displacements and moderate to fast flow rates. All three types involve an inherent instability which is self-triggered at regular intervals, but with type 1 surges, an additional (unknown) mechanism produces the very high flow rates.—*from* Authors' abstract

03833 **Mello, James F.** Foraminifera and stratigraphy of the upper part of the Pierre Shale and lower part of the Fox Hills Sandstone (Cretaceous), north-central South Dakota: U.S. Geol. Survey Prof. Paper 611, 121 p., illus., tables, 1969.

The Virgin Creek, Mobridge, and Elk Butte Members of the Pierre Shale and the lower 74 feet of the Fox Hills Sandstone were studied stratigraphically and for contained Foraminifera. The Mobridge Member is distinguished chiefly by the calcareous nature of the shale; it separates the underlying and overlying noncalcareous shale units. Foraminifera from 101 species, subspecies, or varieties were recognized, including 7 new species. Three foraminiferal biofacies, approximately corresponding to the Virgin Creek, Mobridge, and Elk Butte stratigraphic intervals, are recognized. Comparison with Gulf Coast faunas suggests a probably early Navarro age and others indicate earliest Maestrichtian or latest Campanian age for the upper Pierre Shale. Deposition was in water less than about 200 feet deep.—JFM

04011 **Mereu, R. F.** Effect of Mohorovicic topography on the amplitudes of seismic P waves: Jour. Geophys. Research, v. 74, no. 17, p. 4371-4376, illus., 1969.

Recent crustal and upper mantle seismic experiments such as the 1963 Lake Superior experiment and the Project Early Rise experiment showed that the M-discontinuity may be a very irregular surface. A simple model is presented to illustrate the effect of large-scale undulations along this discontinuity on P-wave amplitude and traveltime curves. Results show that the discontinuity in acting as a lens may: focus the seismic rays, in which case small regions of relatively large amplitudes are produced, or diverge the rays to produce large areas of weaker amplitudes. A comparison of the theory with actual amplitudes observed along the Superior-Churchill line of the Project Early Rise experiment is made.—*from* Author's abstract

04017 **Merrill, R. T.; Kawai, Naoto.** A method for detecting self-reversals using etching: Jour. Geomagnetism and Geoelectricity, v. 21, no. 2, p. 507-512, illus., 1969.

A method using etching by HCl to test for self-reversal in rocks containing two or more magnetic minerals is illustrated by application to specimens from the Bucks batholith in northern California. The etching results support the hypothesis that this batholith contains a self-reversed titanohematite and a normally magnetized magnetite.—Authors' abstract

Metherell, R. G. *See* Workman, L. E. 04021

Meyer, R. P. *See* Borcherdt, C. A. 04040

M'Gonigle, John W. *See* Lucchitta, Ivo. 03751

M'Gonigle, John W. *See* Lucchitta, Ivo. 03752

Michael, Henry N. *See* Ralph, Elizabeth K. 03947

04224 **Milici, Robert C.; Smith, James W.** Stratigraphy of the Chickamauga Supergroup in its type area, *in* Precambrian-Paleozoic Appalachian problems: Georgia Geol. Survey Bull. 80, p. 1-35, illus., 1969; *reprinted as* Tennessee Div. Geology Rept. Inv. 24, 1969.

The Chickamauga Limestone in its type area includes all strata from the top of the Knox Group to the base of the Upper Ordovician and is composed of about 1,450 feet of limestone and argillaceous limestone in formations of the Stones River and Nashville Groups. Considered as a supergroup, the Chickamauga overlies the Knox above a well-developed unconformity, and consists in ascending order of: Pond Spring Formation, Murfreesboro, Ridley, Lebanon, and Carters Limestones of the Stones River Group; and Hermitage Formation, Cannon Limestone, and Catheys Formation of the Nashville Group. The Catheys is overlain unconformably by the Sequatchie Formation in the valley of West Chickamauga Creek, and conformably by the Inman Formation in Lookout Valley. —*from* Authors' abstract

03801 **Miller, George J.** Man and *Smilodon*—A preliminary report on their possible coexistence at Rancho La Brea: Los Angeles County Mus. Contr. Sci., no. 163, 8 p., illus., 1969.

Possible artifactual cuts on fossil bone of extinct animals including the sabre-tooth cat, *Smilodon californicus*, from the Rancho La Brea of California, have recently been uncovered. Preliminary experiments suggest that some of the cuts were made by primitive stone tools. The bone is at least 10,000 years old.—Author's abstract

Miller, John C. *See* Carpenter, Alden B. 03868

03812 **Miller, Norton G.; Benninghoff, William S.** Plant fossils from a Cary-Port Huron interstade deposit and their paleoecological interpretation, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 225-248, illus., 1969.

Plant remains from Cheboygan County [Wis.] suggest that dwarf-shrub tundra or tundra communities within the tundra-boreal forest ecotone were present here between 12,500 and 13,300 B.P. The organic layer has been correlated with Cary-Port Huron interstade deposits and consists mostly of bryophytes. Eight species of mosses, two kinds of leafy liverworts, achenes from *Carex tenuiflora* and/or *C. trisperma*, a perigynium of *C. supina*; leaves of the arctic-alpine plants *Dryas integrifolia*, *Salix herbacea*, and *Vaccinium uliginosum* var. *alpinium*; and *Salix* twigs have been identified from the deposit. Pollen of the bryophyte bed and associated sediments is dominated by nonarboreal pollen. Some of the pollen is rebedded. Macrofossils suggest the presence of distinct communities on wet and dry sites.—*from* Authors' abstract

04189 **Miller, Robert C.** Geologic map of the Canmer quadrangle, Hart County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-816, scale 1:24,000, section, text, 1969.

The known mineral resources of the Canmer quadrangle are limestone from the St. Louis and Ste. Genevieve Limestones and the Girkin Formation, and clay from the unconformable contact between the Tradewater and Caseyville Formations and the Big Clifty Sandstone Member of the Golconda Formation. —MCM

03808 **Milstead, William W.** Studies on the evolution of box turtles (genus *Terrapene*): Florida State Mus. Bull. Biol. Sci., v. 14, no. 1, p. 1-113, illus., tables, 1969.

This report describes and analyzes important North American fossil and Recent box turtle material. Characters investigated include osteological features of the shell and skull as well as scutellation and color. Salient morphologic features, past and present distribution, and evolutionary history of each of the recognized taxa are discussed. No nomenclatural changes are proposed.—Author's synopsis

Misra, S. B. *See* Anderson, M. M. 04102

04256 **Moberly, Ralph, Jr.; Khan, Mohammad Asadullah.** Interpretation of the sources of the satellite-determined gravity field: Nature, v. 223, no. 5203, p. 263-267, illus., 1969.

Anomalies in the Earth's gravity field are probably due to density differences in layers below the lithosphere, and agree with the tectonic model of sea-floor spreading. —Authors' abstract

04219 **Modarresi-G., Hassan.** A contact gage for rapid and accurate three-dimensional grain size measurement of loose sand particles: Jour. Sed. Petrology, v. 39, no. 2, p. 793-797, illus., 1969.

Previous methods for evaluating the c-axis (shortest dimension) of sand-sized particles have proven impractical and have not been widely utilized. This paper describes a new method which permits rapid and accurate c-axis measurement of numbers of sand grains. With this technique sand samples can be simply and efficiently sorted according to c-axis values. —Author's abstract

04220 **Modarresi-G., Hassan.** Relationships of sedimentary bed forms, petrology, and hydraulic equivalence properties of an ancient point-bar sandstone deposit [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4715B-4716B, 1969.

Mohanty, B. B. *See* Savage, J. C. 04031

Molnar, Peter. *See* Isacks, Bryan. 04100

03983 **Moore, Charles Aurelius, Jr.** Mineralogical and pore fluid influences on deformation mechanisms in clay soils [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4647B, 1969.

03863 **Moore, Charles V.; Snyder, J. Herbert.** Some legal and economic implications of sea water intrusion—A case study of ground water management: Nat. Resources Jour., v. 9, no. 3, p. 401-419, illus., table, 1969.

Irrigation water for intensive crop production in Salinas Valley, Calif., comes from pumping an underground basin recharged by percolation from the Salinas River. Salt-water intrusion has forced abandonment of wells near the coast. Two layers of heavy clay near the mouth separate the ground-water basin into three strata. The shallowest is a perched water table with a high accumulation of salts. The other two connect with the river farther up and are under artesian pressure. No significant water-bearing strata are below these. Two storage dams on the Salinas have added new water. A major focus of the report is to define and evaluate legal and economic problems that might be encountered in applying any of six major alternative solutions to the intrusion problem.—ESL

Moore, E. J. *See* Desai, K. P. 03918

04216 **Moore, Neal.** Around the world with 4 million seismic shots—Pt. 1, How the globe-circling geophysical survey was made and some of the exciting observations: Ocean Industry, v. 4, no. 4, p. 47-50, illus., 1969.

A seismic survey covering 25,000 mi of subsea bottom, using a super sparker system designed for high-speed continuous operation, is described. The 3,000 mi length profiled during the Atlantic crossing was discussed in the October 1967 *Ocean Industry*. The most interesting features off the African coast were the complex struc-

tures. Data did not tie Madagascar to the mainland and indicate that the channel between them may be newly formed. The surveying vessel, the *Stranger*, went on to Singapore, and finally up the China Sea and profiled the Pacific to its home port of San Diego. Better instruments have been designed since this voyage. —ESL

03795 **Morey, G. B.** The geology of the Middle Precambrian Rove Formation in northeastern Minnesota: Minnesota Geol. Survey Spec. Pub. Ser. SP-7, 62 p., illus., tables, 1969.

The Rove Formation, of the upper Animikie and about 3,200 feet thick, was deposited 2.0 to 1.7 b.y. ago. Detailed mapping in South Lake quadrangle, with field and laboratory study of 150 stratigraphic sections, furnishes the basis for recognition of three informal units. Postdepositional soft-sediment structures indicate rapid deposition, and paleocurrent indicators show that turbidity currents had a southerly trend. Heavy minerals of the Rove are typical of older Precambrian igneous rocks. Thin-section and X-ray analyses show that graywackes consist of poorly sorted grains of clastic quartz and plagioclase embedded in an argillaceous matrix. Argillite and mudstone have the same mineralogy as the graywacke. Erosion removed part of the formation prior to deposition of lower Keweenawan rocks. Intrusion of middle Keweenawan mafic rocks caused local metamorphism.—*from* Author's abstract

Morgan, Charles O. *See* Ropes, Leverett H. 03716

03717 **Morgan, Charles O.; McNellis, Jesse M.** Stiff diagrams of water-quality data programmed for the digital computer: Kansas Geol. Survey Spec. Distrib. Pub. 43, 27 p., illus., tables, 1969.

Stiff diagrams, pattern diagrams used in interpretation of quality-of-water data, are calculated and printed with the aid of the GE 625 digital computer at the rate of approximately 170 per minute. A range of scales for the diagrams is specified for each group of data. Each complete analysis is diagrammed if the cations and anions balance within 2, 3, or 5 percent, depending upon the amount of dissolved solids. —Authors' abstract

Morgan, Charles O. *See* McNellis, Jesse M. 03718

Morgan, Charles O. *See* McNellis, Jesse M. 03799

Morris, G. B. *See* Raitt, R. W. 03921

04032 **Morris, G. B.; Raitt, R. W.; Shor, G. G., Jr.** Velocity anisotropy and delay-time maps of the mantle near Hawaii: Jour. Geophys. Research, v. 74, no. 17, p. 4300-4316, illus., tables, 1969.

Standard and special seismic refraction profiles resulting in 1,147 critically refracted mantle traveltimes were conducted across the Hawaiian arch. Results show that the upper mantle immediately beneath the M-discontinuity is anisotropic with respect to compressional waves. Maximum velocity occurs in an E-W direction and is 0.6 kmps greater than the minimum, which occurs in a N-S direction. Lateral variations in mean mantle velocity (8.16 kmps average) also are indicated. Crustal thicknesses reflect the topographic arch. Directly north of the island of Hawaii, the crust is about 6.0 km thick, but thins to about 5.3 km in both directions along the crest of the arch. The crust thickens beneath the southwestern flank of the arch, reaching 7.5-8.0 km in the Hawaiian deep. —*from* Authors' abstract

03754 **Mower, R. W.** Ground-water inflow toward Jordan Valley through channel fill in seven canyons in the Wasatch Range near Salt Lake City, Utah, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C174-C176, illus., 1969.

The estimated quantity of underflow moving toward the Jordan Valley in the channel fill of 7 major canyons in the Wasatch Range near Salt Lake City, Utah, is 3,400 acre-feet of water per year. About 2,000 acre-feet of this water is discharged by springs

and wells before it reaches the principal ground-water reservoir in the valley, leaving about 1,400 acre-feet per year available for recharge. About 93 percent of the recharge is from Little Cottonwood Creek Canyon and 7 percent from the other 6 canyons.—Author's abstract

03755 **Moxham, R. M.** Aerial infrared surveys at The Geysers geothermal steam field, California, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C106-C122, illus., table, 1969.

An infrared radiance pattern on aerial infrared images of The Geysers area extends beyond the present (1968) northwest limit of steam production, and suggests slightly elevated surface temperatures. The radiance zone seems to coincide in part with a mapped fault, across which a surface temperature difference was measured. The principal high-temperature zones are bounded at the surface on the southwest by thermal lineaments, suggesting some corresponding structural control. The abnormal radiance at The Geysers is restricted to hydrothermal alteration zones and other local features. No evidence was found of a regional geothermal anomaly at the surface in The Geysers area, within the detection limit of the equipment used in this survey. —Author's abstract

Moxham, R. M. *See* Boynton, G. R. 03756

Müller, Fritz. *See* Jonas, John J. 03915

03930 **Müller, Fritz.** Was the Good Friday Glacier on Axel Heiberg Island surging?, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 891-894, illus., 1969.

The lower part of the Good Friday Glacier on Axel Heiberg Island, N.W.T., started, sometime between 1952 and 1959, a period of markedly increased movement associated with a frontal advance of over 2 km, which showed clearly some of the features attributed to a glacier surge, while others were lacking. Such border cases merit special attention.—Author's abstract

03939 **Müller, Fritz.** (chairman). Introduction, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. iii-iv, 1969.

The rapid growth of interest in glacier surging resulted, to a large extent, from publicity given the dramatic 1966-68 surge of Steele Glacier (Yukon) and the Allalin Glacier catastrophe (Switzerland) in 1965, as well as the suggestion of A. T. Wilson of New Zealand that surges of continental ice sheets may initiate large-scale climatic changes, which might bring on an ice age. This seminar, the second held in Canada in 1968, includes discussions that followed presentations of the papers. An *ad hoc* working group prepared a list of eight recommendations for further research on glacier surging.—MCM

04112 **Murdock, James N.** Crust-mantle system in the central Aleutian region—A hypothesis: Seismol. Soc. America Bull., v. 59, no. 4, p. 1543-1558, illus., tables, 1969.

Seismic data acquired during the 1964 VELA UNIFORM Aleutian experiment have been used to construct a model of the local crust-mantle system. The M-discontinuity of the model has a synclinal structure whose axis coincides with the islands of the arc. Just south of the islands, the shoaling M is terminated by a northward-dipping thrust fault, resulting in a wedge-shaped crustal block sandwiched between mantle components. —Author's abstract

Murray, J. W. *See* Kellerhals, Peter. 04020

Murthy, V. Rama. *See* Condie, Kent C. 03701

04311 **Myers, B. N.** Compilation of results of aquifer tests in Texas: Texas Water Devel. Board Rept. 98, 532 p., illus., tables, 1969.

This report presents a compilation of available data on hundreds of aquifer tests in Texas and provides a reference to the hydraulic characteristics of the various aquifers. The form in which the material is presented is considered complete enough to permit the user to reevaluate results or make other interpretations in cases where reliability of tests was questionable. Data are grouped by county and where possible the latitude and longitude of the well are given on the graph accompanying each well test. —MCM

Myers, Donald A. *See* Bachman, George O. 03720

04184 **Mylrea, F. H.** Geology of Mica damsite, Columbia River, British Columbia [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 57-64, illus., 1969.

Mica Dam, presently under construction, is located on the Columbia River about 90 mi north of Revelstoke. The foundation rock has been explored by 40,000 feet of diamond drilling; exploratory work has also been done for borrow materials, and a tunnel driven in each abutment. In the river bed, surficial deposits, mainly glacial till, may be up to 150 feet thick; layers of volcanic ash occur with the drift and correlate with the Bridge River and Mazama ash in other areas. Mica schist and paragneiss comprise the Precambrian bedrock. Rock mechanics tests were carried out. Unconfined compressive strengths range from 2,000 psi for the schist to 20,000 psi for the granite gneiss. —ESL

04263 **Naff, John D.** Geology of the Lemon-Ptarmigan area, Alaska: Oklahoma Acad. Sci. Proc. 1967, v. 48, p. 110-112, 1969.

Lemon and Ptarmigan Glaciers, on the west edge of Juneau Icefield, are ideal field research models, as they show typical features of alpine glaciation within a small area and are accessible by helicopter through most of the year. The two glaciers, about 3.5 and 2.75 miles long respectively, extend northward along each side of Ptarmigan Ridge, an arête of bedrock predominantly graywacke of low metamorphic grade intruded by pegmatite dikes. Both glacial valleys have very steep gradients and follow major joint lineations and cols. Ptarmigan Glacier is a drainage system separate from the main icefield. —VMJ

Natl. Acad. Eng. Comm. Ocean Eng. *See* Natl. Acad. Sci. Comm. Oceanography. 03685

03685 **Natl. Acad. Sci. Comm. Oceanography; Natl. Acad. Eng. Comm. Ocean Eng.** An oceanic quest—The International Decade of Ocean Exploration: Natl. Acad. Sci. Pub. 1709, 115 p., illus., tables, 1969.

This report was prepared to serve as a useful basis for discussion and planning both nationally and internationally for the proposed International Decade of Ocean Exploration for the 1970's. The contents of the book are: prologue; summary and major recommendations; beneath the sea—geology, geophysics, and nonliving resources (potential mineral resources, small ocean basins, deep drilling, plate tectonics, deep ocean exploration); vital stuff—biology and living resources; two fluids—physics and environmental prediction; source and sink—geochemistry and environmental change (geochemical ocean-section study, transport processes); and ways and means —funds, technology, program management, associated social studies, international cooperation.—MCM

03906 **Naughton, John J.; Derby, James V.; Glover, Richard B.** Infrared measurements on volcanic gas and fume—Kilauea eruption, 1968: Jour. Geophys. Research, v. 74, no. 12, p. 3273-3277, illus., 1969.

Infrared spectra from Kilauea volcano, Hawaii, show absorption by volcanic and atmospheric gases. The composition of the main volcanic gaseous components within the primary fountain is estimated to be H_2O, 95 percent; CO_2, 4 percent; and SO_2, 1 percent. These results are reasonable in the light of the contribution of volatiles to the budget of the elements in the Earth's crust. The wavelength of scattered radiation indicates an upper size limit of about 4μ for fume particles.—Authors' abstract

04051 **Negi, Janardan G.; Garde, Subhash C.** Symmetric matrix method for rapid gravity interpretation: Jour. Geophys. Research, v. 74, no. 15, p. 3804-3807, illus., 1969.

A symmetric matrix is introduced to specify a set of variable densities. An iterative process is generated by means of such a matrix formulation, which leads to an elegant and rapid method for calculating the configuration of two-dimensional subsurface mass deficiencies, such as sedimentary basins and isostatic structures below the mountains. Applications are illustrated for Godavari Basin (India) and the Rocky Mountains. —Authors' abstract

Nelson, Richard V., Jr. *See* Hoskin, Charles M. 04067

Neophytou, J. P. *See* Beck, A. E. 04076

04287 **Nettleton, W. D.; Holzhey, C. S.; Flach, K. W.; Brasher, B. R.** Soil scientists' proficiency in describing soil consistence: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 320-321, tables, 1969.

A recent field trip for a group of soil scientists from the western United States permitted comparison of professional soil scientists' description of dry and moist soil consistence and comparison of the descriptions of consistence with unconfined compressive strengths of dry soil. Field party members agreed fairly well with each other in the description of the consistence of moist soils (60 percent agreement) and dry soils (70 percent agreement). There was a logarithmic relation between their description of dry consistence and unconfined compressive strengths. The unconfined compression test thus seems to provide a suitable soil consistence standard. The range in unconfined compressive strengths within classes increases from the slightly hard to the very hard classes. —Authors' abstract

04322 **Nettleton, W. D.; Flach, K. W.; Brasher, B. R.** Argillic horizons without clay skins: Soil Sci. Soc. America Proc., v. 33, no. 1, p. 121-125, illus., tables, 1969.

Fine-textured subsoil horizons of some soils of the southwestern United States do not have distinct clay skins. The occurrence of clay skins is related to the shrink-swell potential and the associated configuration of the soil plasma. Cyclic shrinking and swelling destroy clay skins or prevent their formation. Hence such horizons without clay skins can be argillic horizons. —Editor's brief

04324 **Neuschel, Sherman K.** Natural gamma radioactivity map of the Minneapolis-Saint Paul area, Minnesota-Wisconsin: U.S. Geol. Survey Geophys. Inv. Map GP-658, scale 1:250,000, text, 1969.

Natural gamma radioactivity of the Minneapolis-St. Paul area (here includes central part of the state) ranges from 50-550 cps; changes in levels are due to varying radionuclide content of glacial materials and the few bedrock exposures. Bedrock is buried to a depth of nearly 500 feet by glacial deposits; present topography is the result of glaciation. Narrow ribbons of low radioactivity (50-300 cps) are associated with sandy alluvium in major stream valleys. Values of 350-450 cps over Patrician drift north and along the St. Croix River are probably due to a higher percentage of pebbles and cobbles of crystalline rocks. Many small elongate areas of low radioactivity (50-150 cps) with a northeast trend parallel direction of ice movement. The highs—450-550 cps southwest of St. Cloud, 400-500 cps in Kanabec County—are over granite exposures, or granite protrusions through glacial drift, respectively. —MCM

04158 **Newbury, R. W.; Cherry, J. A.; Cox, R. A.** Groundwater-streamflow systems in Wilson Creek Experimental Watershed, Manitoba: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 613-623, illus., 1969.

Preliminary studies of the groundwater-streamflow systems in the Wilson Creek Watershed in southwestern Manitoba indicate that the hydrochemical characteristics of the system may be used to: (1) identify the base flow component of storm runoff hydrographs; and (2) determine what proportions of the base flow are derived from in-basin and out-of-basin recharge areas.—Authors' abstract

04209 **Newton, Robert C.; Goldsmith, Julian R.; Smith, Joseph V.** Aragonite crystallization from strained calcite at reduced pressures and its bearing on aragonite in low-grade metamorphism: Contr. Mineralogy and Petrology, v. 22, no. 4, p. 335-348, illus., tables, 1969.

Thermochemical data show that at least 200 cal/mol of strain energy can be produced in calcite by mild deformation. This much stored energy would lower the pressure requirements of aragonite, *relative to the strained calcite*, by more than 3 kb and our observations that aragonite growth was faster than strain recovery of calcite indicates that aragonite can grow in nature at reduced pressures from strained calcite. Some experiments on highly magnesian calcites showed that no aragonite was produced, but the possibility of this mechanism in nature cannot be discounted. Microtextures of deformed marbles from Washington, as well as electron probe analyses, show that aragonite selectively replaced highly strained calcite. The calcite-aragonite transition is thus a questionable indicator of high pressure in certain metamorphic rocks. —*from* Authors' abstract

03742 **Neyland, Herbert M.** Orthophotoscope modifications, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C240-C242, illus., 1969.

The orthophotograph, the principal product of the Orthophotoscope, is widely used for urban planning, geologic studies, map revision, and orthophotomapping. Improved resolution in orthophotographs has resulted from recent modifications to the T-64 Orthophotoscope which permit the accomodation of a full-size 9- × 9-inch diapositive plate. Besides sharper resolution, the new design makes possible the use of color photographs in the instrument. — Author's abstract

04110 **Niazi, Mansour.** Use of source arrays in studies of regional structure: Seismol. Soc. America Bull., v. 59, no. 4, p. 1631-1643, illus., tables, 1969.

Study of seismograms of 26 underground explosions and 2 cavity collapses at the Nevada Test Site and 26 central California earthquakes, reveals that use of source arrays instead of instrument arrays may provide information of a general nature on crust-upper mantle structure. Times of four consistent arrivals on the NTS seismograms are analyzed. The first two arrivals, with apparent velocities of 8.51 ± 0.47 and 6.41 ± 0.23 kmps, are interpreted as Pn and Pg phases, respectively. A later arrival, P_gP with velocity of 9.80 ± 0.86 kmps, is consistent with P reflections from 227 ± 22 km. Phases obtained on the seismograms of the California earthquakes suggest a single-layer crust with average thickness of 20.5 km, south of Berkeley. Crustal P and S velocities are 5.87 ± 0.05 and 3.46 ± 0.05 kmps, and Pn and Sn velocities are 7.91 ± 0.12 and 4.40 ± 0.10 kmps. —DBV

03996 **Nicholas, John.** Late Pleistocene palynology of southeastern New York and northern New Jersey [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4716B, 1969.

03683 **Nicholls, J.; Carmichael, I. S. E.** A commentary on the absarokite-shoshonite-banakite series of Wyoming, U.S.A.: Schweizer. Mineralog. u. Petrog. Mitt., v. 49, no. 1, p. 47-64, illus., tables, 1969.

These richly porphyritic volcanics are characterized by calcic plagioclase and sanidine coexisting in the groundmass. Both show a wide range of composition and become more sodic as crystallization proceeds; plagioclase phenocrysts, often with sanidine rims, are no more calcic than the groundmass. Augite and calcium-poor pyroxene, with olivine, are found as phenocrysts and groundmass constituents in many lavas. Augite phenocrysts commonly have almost no zoning, and match the composition of their groundmass counterparts; groundmass olivine is more iron-rich than associated phenocrysts. Overall composition of the rocks is distinctive, in spite of alteration and presence of xenocrysts, as they are notably potassic and rich in Sr, Ba, the light rare earths, and P. However, the tholeiitic aspect of shoshonites makes them inappropriate to give title to the potassic alkaline magma series proposed by Joplin.—*from* Authors' abstract

04107 **Nichols, Harvey.** Chronology of peat growth in Canada: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 6, no. 1, p. 61-65, illus., table, 1969.

Published and unpublished radiocarbon dates from immediately above the unconformable mineral bases of ombrogenous peat bogs are compared with the climatic history of Canada during the last 4,000 years. Most of the determinations group around a few periods of established climatic deterioration (such as 3,500 and 2,400 B.P.) which suggests that large tracts of Canadian peat originated almost simultaneously under the stimulus of climatic change. —Author's abstract

Nichols, Thomas C., Jr. *See* Lee, Fitzhugh T. 03757

03914 **Nielsen, Lawrence E.** The ice-dam, powder-flow theory of glacier surges, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 955-959, illus.; discussion, p. 959-961, 1969.

It is assumed that a stagnant ice block or dam develops in the lower regions of a glacier. Ice gradually builds up above the dam while the dam itself becomes thinner by ablation. Eventually the upper end of the stagnant ice block crumbles from the force of overlying ice and the glacier is changed from a state of compression to one of tension. Breaking of the ice dam results in rapid breakage of the glacier into blocks or powdered ice. Apparent viscosity of the broken glacier is much less than that of bulk ice, so high velocities of flow are possible, and a phenomenon similar to a mud flow results. This theory explains why some glaciers repeatedly surge yet appear stagnant between surges. The broken-up appearance of surging glaciers and the delayed surging of tributaries are explained.—Author's abstract

03758 **Noble, Donald C.; Hedge, Carl E.** Sr^{87}/Sr^{86} variations within individual ash-flow sheets, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C133-C139, illus., tables, 1969.

Vertical changes in initial strontium isotope composition within each of five upper Cenozoic ash-flow sheets of the Great Basin, U.S.A., indicate that the parent magmas were isotopically zoned prior to eruption. Such zonation, which cannot have resulted from differentiation, probably can be explained by the incorporation of radiogenic sialic material by the upper parts of less radiogenic magmas as they ascended through the Earth's crust.—Authors' abstract

03710 **Norris, Stanley E.; Fidler, Richard E.** Hydrogeology of the Scioto River valley near Piketon, south-central Ohio: U.S. Geol. Survey Water-Supply Paper 1872, 70 p., illus., tables, 1969.

The systematic study of one of Ohio's principal aquifers, a sand and gravel outwash in the Scioto River valley, to determine feasibility of developing a ground-water supply of 20 million gpd near Piketon was in three parts: (1) determining thickness and physical properties of the aquifer and drilling test wells for well sites; (2) aquifer infiltration test to determine hydraulic properties and conditions of stream recharge; and (3) testing and quantitative evaluation of the four supply wells located by (2) before they were put into service. Coefficient of transmissibility was 215,000 gpd/ft; rate of streambed infiltration was 0.235 mgd/acre/ft. The aquifer was tested near the end of a long drought so ground-water levels and river stage were very nearly following a level trend.—*from* Authors' abstract

04134 **North, William G.** The Middle Devonian strata of southern Illinois: Illinois Geol. Survey Circ. 441, 45 p., illus., 1969.

Middle Devonian rocks, long a major source of oil in the Illinois Basin, are exposed in a small area along the Mississippi Valley in the extreme southwestern part of the state; in outcrop they have a strikingly different composition from equivalent strata in the deep part of the basin, consisting of shallow-water carbonates that become shaly upward. Facies and thickness variations are related to shallowing of water over positive areas. Lingle Limestone is subdivided into: Howardton Limestone,

Tripp Limestone, Misenheimer Shale, and Walnut Grove Limestone; all members except Misenheimer are new. A widespread oolite bed in the Walnut Grove, Rendleman Oolite Bed, is also new. These units, with distinctive geophysical key beds in the Sweetland Creek Shale, permit detailed tracing of Middle Devonian strata across the Illinois Basin. —*from* Author's abstract

Nur, Amos. *See* Simmons, Gene. 03708

Obradovich, J. D. *See* Kistler, R. W. 03898

04225 **Ocean Industry.** Gulf of Mexico, giant deep-water oil province of future,: Ocean Industry, v. 4, no. 5, p. 68-72, illus., 1969.

The *USNS Kane* has found added seismic evidence of a maze of structures in the Gulf of Mexico. Many appear to be salt, some standing 15,000-25,000 feet above their bases. A large salt deposit may have formed during the Mesozoic and was buried during the Cenozoic. This deposition, and subsidence of the basin, could mobilize the salt body. If some are oil traps, then it might result in exploration and development of other deep basins. This is a joint project of the U.S. Geological Survey and the Naval Oceanographic Office. —ESL

04183 **Okulitch, Andrew V.** Polyphase deformation in the Kobau Group, Mount Kobau, British Columbia [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 47-56, illus., 1969.

The Kobau Group, between the Okanagan and Similkameen valleys, consists of quartzite, schist, and greenstone metamorphosed to the greenschist facies. The first period of deformation produced an east-west trending penetrative lineation and tightly compressed nappe structures with southerly-dipping axial planes. Metamorphism accompanied folding. A second produced overturned and normal folds with northwest axes and deformed first period structures. Numerous small Mesozoic intrusions may have been emplaced during or succeeding the second deformation. A third deformation producing gentle folds and poorly defined north-trending axes may be related to this intrusive episode. Tertiary faults form the Mt. Kobau horst, and break pre-existing structures into blocks and wedges. The faults parallel axial planes of the first two deformations and other faults in the Okanagan Valley. —*from* Author's abstract

03788 **Ollier, Cliff.** Weathering: New York, Am. Elsevier Publishing Co. (Geomorphology 2), 304 p., illus., tables, 1969.

In this textbook, weathering is considered not only as reduction of minerals to fundamental particles, but also as formation of new minerals in a weathering profile. Processes, material operated upon, and products are all considered together with the time factor treated on the geological scale. Chapter headings are: introduction, physical weathering, chemical weathering, biotic weathering, mineral weathering, clay minerals, rock weathering, hydrology and weathering, climate and weathering, deep weathering, soils, weathering and evolution of landforms, weathering rates, weathering through geological time, and techniques. An extensive bibliography and an index are included.—MCM

04214 **Ondrick, C. W.; Suhr, N. H.** Error and the spectrographic analysis of graywacke samples: Chem. Geology, v. 4, nos. 3-4, p. 429-437, illus., tables, 1969.

Two experiments were set up to evaluate subsampling variation for both major/minor and trace elements. The 119 samples of Rensselaer Graywacke showed fluctuations in percentages that were smaller than the analytical error so that subsampling variation appears to be negligible for major/minor elements when the samples are ground to minus 200 mesh. The spectrographic analysis of 31 different plates showed fluctuations of trace elements which are a result of the combination of analytical and subsampling errors. The reliability of single or even duplicate determinations of trace concentrations of Cr, Cu, La, and Zr by emission spectroscopy leaves something to be desired. —*from* Authors' abstract

04231 **Ondrick, C. W.; Suhr, N. H.; Medlin, J. H.** Investigation into increasing the precision of a rotating disk-solution technique for the analysis of silicates: Appl. Spectroscopy, v. 23, no. 2, p. 111-115, illus., tables, 1969.

The precision of major-minor silicate analyses employing a rotating disk-solution technique may be improved by restricting the number of sparkings on each end of the counter electrode to no more than two; and by placing a more rigid control on disk weight than presently supplied by the manufacturer, i.e., prior to sparking, weigh the disks and place them in weight categories with a range no greater than 30 mg. Room temperature fluctuations of 5°F or less are enough to decrease precision, and to maintain maximum precision, a tighter control on room temperature is required. Changes in barometric pressure affect precision of certain major and minor oxides, therefore, during periods of stable barometric pressure the precision of the analysis is at an optimum. Relative humidity in the range of 40-60 percent and minor shifts in the optical alinement of the grating appear to have little effect on the precision. —*from* Authors' abstract

03849 **Opdyke, N. D.; Henry, K. W.** A test of the dipole hypothesis: Earth and Planetary Sci. Letters, v. 6, no. 2, p. 139-151, illus., tables, 1969.

The magnetic inclinations of 52 cores from all oceans of the world were studied in an attempt to test the hypothesis that, when averaged over periods of 10^5 years or so, the axis of the Earth's magnetic field coincides with the axis of rotation. Inclination versus latitude plots were constructed and the best fitting geocentric dipole was calculated. This is located at 89° N., 211° E. It is concluded that when averaged over periods of time on the order 10^5-10^6 years, at least for the past 2 million years, the Earth's field closely approximates a geocentric axial dipole.—Authors' abstract

Opdyke, N. D. *See* Roy, J. L. 04010

04118 **Orr, William N.** Variation and distribution of *Globigerinoides ruber* in the Gulf of Mexico: Micropaleontology, v. 15, no. 3, p. 373-379, illus., 1969.

The population of the planktonic foraminiferal species *Globigerinoides ruber* from sediments in the northwest Gulf of Mexico changes considerably in character in basinward traverses. One variety of *G. ruber* may belong to a group of planktonic foraminifera which are allochthonous to the Gulf. Some of the delicate structures of *G. ruber* which are rare in fossil specimens may imply rapid biologic sedimentation, where they are prevalent in populations from marine sediments. —Author's abstract

04063 **Osborne, Robert H.** The American Upper Ordovician standard—[Pt.] 11, Multivariate classification of typical Cincinnatian calcarenites: Jour. Sed. Petrology, v. 39, no. 2, p. 760-776, illus., tables, 1969.

The observed petrographic variables are: broken and whole brachiopods and bryozoans, crinoids, total broken and total whole skeletal grains, total skeletal grains, micrite, sparite, and insoluble residue. All combinations of nondiagonal elements were tested by the Generalized Mahalanobis D^2 Statistic (V) and a probability of <0.001 was indicated for each combination. Discriminant functions and classification matrix were then computed for sample A. Interclass and intraclass variation was tested by thin sections (sample B). All combinations of A and B subgroups were tested using the V statistic. IL and 3S classes were eliminated, and subgroups 1-2A and 1-2B and 3A and 3B were pooled using sample means. Factor analyses for the pooled groups suggest 2 groups, classes 1-2 aand 3. A discriminant function and a classification matrix classify more efficiently than aassociated factor clusters. —*from* Author's abstract

03686 **Osterwald, Frank W.; Dunrud, C. Richard; Maberry, John O.** Preliminary geologic map of the Columbia area, Carbon and Emery Counties, Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-582, 2 sheets, scale 1:6,000, 1969.

Oversby, V. M. *See* Compston, W. 04029

03911 **Overton, Harold L.; Timko, Donald J.** The salinity principle—A tectonic stress indicator in marine sands: Log Analyst, v. 10, no. 3, p. 34-43, illus., 1969.

A new indicator allows major local tectonic features to be determined from a single well. The only measurement required, besides mud filtrate resistivity and temperature, is the shale porosity log; determinations from this indicator include locations of fault zones, compaction stress changes, abnormal pressures, and permeable sands of significant extent. The method is simple and may be cross-checked with the density or traveltime log. It involves several simple principles: A, (water salinity) (shale porosity) = constant; B, (shale porosity) = (overburden-hydraulic pressure). Water salinity may be accurately determined from clean sands, and a complete well profile is needed to make an analysis. Several analyses are made, where the various stresses have been confirmed. Mathematical theory and laboratory results are also presented.—*from* Authors' abstract

Owen, Donald E. *See* Lenė, Gene W. 04061

04283 **Owen, M. W.** Deposition of suspended particles in a gravel bed—Discussion [of paper 6102 by H. A. Einstein, 1968]: Am. Soc. Civil Engineers Proc., v. 95, Jour. Hydraulics Div., no. HY 3, p. 1085-1087, table, 1969.

By reconsidering the determination of the theoretical value of the dimensionless Tv_*/d, it is possible to show that the mean value is slightly closer to the theoretical value than Einstein claims in paper 6102 (ibid., v. 94, no. HY 5, p. 1197-1205, 1968). His results are compared with determinations by T. R. Camp (1943) of deposition of a wide range of sediment sizes, over a wide range of hydraulic conditions. Signs of flocculation, which is also affected by turbulence, could help to explain the wide variation in values of v_*T/d for the finer fractions. Naturally occurring silts will almost certainly show some sign of flocculation in river water. —GDC

Page, Harold T. *See* Kiss, Klara. 04176

04258 **Pageau, Yvon.** Nouvelle faune ichthyologique du dévonien moyen dans les Grès de Gaspé (Québec)—[Pt.] 2, Morphologie et systematique—Sec. 1, Euryptérides, Ostracodermes, Acanthodiens et Sélaciens [with English abs.]: Naturaliste Canadien, v. 96, no. 3, p. 399-478, illus., tables, 1969.

A new fish fauna is described from the Middle Devonian Gaspé Sandstone; in [Pt.] 1 (Pageau, 1968), the geology and ecology are treated, and in a succeeding part the arthrodire fishes will be described. Ostracoderms are represented by portions of cephalic shields, with some endocranial structures, of seven species of *Cephalaspis*, including three new species, *lunata*, *peninsulae*, and *sydenhami*. Acanthodians, represented by scales and spines, are *Climatius latispinosus*, *Mesacanthus semistriatus*, *Cheiracanthus costellatus*, *Machaeracanthus* spp. A and B, and *M. major*. Two selachian spines are questionably referred to *Ctenacanthus ornatus*. Eurypterid segments of *Pterygotus gaspesiensis* and eurypterid fragments probably of other species are associated with the fish remains. —VMJ

04125 **Paine, Robert T.** Growth and size distribution of the brachiopod *Terebratalia transversa* Sowerby: Pacific Sci., v. 23, no. 3, p. 337-343, illus., tables, 1969.

Size-frequency distributions in brachiopod populations are uninterpretable biologically unless growth patterns and approximate growth rates of individuals are known. One feasible approach to age determination is synchronized sampling of living populations from manmade structures of known but varying ages. Marina and sewer-outlet structures of four different ages, from 5 to 13 years, in Puget Sound at Seattle, Wash., were sampled to construct a growth curve for *Terebratalia*. Modes indicative of the first four or five year classes were recognized, and seem internally consistent. Older year classes were indistinguishable; maximum age of individuals in this area is probably about 10 years. Growth lines, though conspicuous shell features, are not related to age. —VMJ

Pakiser, L. C. *See* Iyer, H. M. 04039

Palmer, C. Sweet. *See* Johnson, Stanley S. 03675

03759 **Palmer, James E.** Fault scarp exposures in the Saint Charles and Nortonville quadrangles, western Kentucky, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C75-C78, illus., table, 1969.

Many fault scarps exposed by strip mining operations provide an opportunity to observe features of faults not commonly seen, but weathering and erosion rapidly destroy the features. The fault scarps are in a region of relatively intensive faulting south of the Rough Creek fault zone, and east of the Illinois-Kentucky fluorspar district. Data from more than 20 excellent exposures indicate that the faults dip from 51° to 90°, and are remarkably straight over considerable distances, with only local irregular variations. Extensive slickensided surfaces showing only vertical movement, limited brecciation, and the development of fault slices were noted at several exposures.—Author's abstract

03680 **Pamatmat, Mario M.; Banse, Karl.** Oxygen consumption by the seabed—[Pt.] 2, *In situ* measurements to a depth of 180 m: Limnology and Oceanography, v. 14, no. 2, p. 250-259, illus., tables, 1969.

Oxygen consumption by the seabed was measured in Puget Sound by bell jars pushed into the bottom. Depths varied from 11 to 180 m and sediments varied from coarse sand to mud. Observed short-term rates were from 4 to 40 ml O_2/m/hr and were unrelated to depth, mean grain size, fine fraction, organic matter, or organic N in the upper 0.5 cm or biomass of macrofauna. Temperature accounted for 30 percent of the variation only; rates are primarily the results of changes of small organisms governed by plankton supply. Estimates of annual rates of oxidation of organic matter on the seabed correspond to 17 and 25 percent of the phytoplankton production in the northern and southern Puget Sound, respectively.—*from* Authors' abstract

03816 **Papadopoulos, George T.; Laguros, Joakim G.** Programming for Pavlovsky's ground-water problem—Closure [to paper 5840, 1968]: Am. Soc. Civil Engineers Proc., v. 95, Jour. Irrigation and Drainage Div., no. IR 2, p. 352, 1969.

This closure summarizes paper 5840 (ibid., v. 94, no. IR 2, p. 49-56, 1968). A computer 1410 program is presented for calculating unconfined flow between two water bodies above an inclined impervious layer with Pavlovsky's solution, by using the method of false position which provides the value of the normal depth of flow. Thus, a trial and error graphical solution is avoided and the seepage line is readily established; also, the quantity of seepage can be calculated by an appropriate equation. The essential advantage of the programmed solution is its versatility.—GDC

04178 **Parham, Walter E.** Formation of halloysite from feldspar—Low temperature, artificial weathering versus natural weathering [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 17, no. 1, p. 13-22, illus., tables, 1969.

Weathering products formed on plagioclase and K-feldspars, leached for 140 days, are morphologically identical to natural products developed on K-feldspars weathered under conditions of good drainage in the humid tropics. As weathering continues, bumps grow outward to form tapered projections, which form one continuous flame-shaped sheet. Those on K-feldspar may roll to form tubes inclined at a high angle to the feldspar surface. It is inferred from its morphology that this weathering product is halloysite or its primitive form. Flame-shaped films formed on artificially weathered plagioclase do not develop into hollow tubes but give rise to a platy mineral, probably boehmite. Plates form within the flame-shaped films, and with continuous weathering are released as film deteriorates. There is no indication that platy pseudohexagonal kaolinite forms from any of these minerals under the initial stage of weathering. —*from* Author's abstract

03824 **Parizek, Richard R.** Glacial ice-contact rings and ridges, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 49-102, illus., 1969.

These minor landforms associated with end moraines, hummocky and transitional ground moraines, hummocky and pitted outwash plains, moraine-lake plateaus, moraine plateaus, former ice-walled and ice-floored valleys, and other glacial landforms were investigated in south-central Saskatchewan. Conspicuous on aerial photographs, they resemble rings that are several hundred feet to several miles in diameter and a few tens of feet in relief. They are the end-products of wasting stagnant- or dead-ice masses of various sizes and may be used to determine the manner and history of ice-retreat and the most probable origin of associated land forms. The nature, proposed mechanism, and environment of formation of diverse ice-contact rings and ridges are illustrated.—*from* Author's abstract

03681 **Park, P. Kilho.** Oceanic CO_2 system—An evaluation of ten methods of investigation: Limnology and Oceanography, v. 14, no. 2, p. 179-186, illus., 1969.

By combining two or more of the parameters pH, carbonate alkalinity, total carbon dioxide, and partial pressure of carbon dioxide, six equations can be obtained to express the concentration of carbonic acid that include molecular carbon dioxide, ten equations for bicarbonate ion, and eleven equations for carbonate ion concentrations. When the present-day analytical precision and the normal oceanic variances of the above four parameters are considered, the pH-partial pressure of carbon dioxide combination is the most promising to study the oceanic CO_2 system.—Author's abstract

04244 **Parker, A.** Some trace element determinations on the new U.S.G.S. silicate rock standards: Chem. Geology, v. 4, nos. 3-4, p. 445-449, tables, 1969.

Values for the Ti, V, Cr, Mn, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Sn, Ba, La, and Pb contents of the new U.S.G.S. silicate rock standards are given. The results were obtained by X-ray fluorescence analysis. A calibration method was used which involved spiking of the samples with small quantities of the elements to be measured. This avoided the errors due to matrix effects, usually associated with the analytical technique. —Author's abstract

03867 **Parker, John William.** Water history of Cretaceous aquifers, East Texas Basin, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 111-133, illus., 1969.

Five Cretaceous aquifers are investigated; the major ions, Ca^{+2}, Mg^{+2}, Na^{+}, SO_4^{-2}, and HCO_3^{-}, show each aquifer to have distinct characteristics, but there are interconnections between aquifers, especially near the Mexia-Talco fault zone and at an unconformity that extends across the Sabine uplift. Some piercement salt domes modify the water, but most have no noticeable effect. Hot brine moves from east to west from the Tyler basin, accounting in part for the East Texas oil field to the west of the Sabine uplift. Ion ratio comparisons show that water in the older, more deeply buried aquifers have been modified more (compared with present day sea water) than in younger, less deeply buried aquifers.—*from* Author's summary

Patman, J. H. *See* Alexander, W. H., Jr. 04318

03807 **Patton, Thomas Hudson.** Miocene and Pliocene artiodactyls, Texas Gulf Coastal Plain: Florida State Mus. Bull. Biol. Sci., v. 14, no. 2, p. 115-226, illus., tables, 1969.

This report describes 27 species of fossil artiodactyls and discusses their systematic positions. New are *Australocamelus*, the probable *Aepycamelus* ancestor, and *Nothotylopus*, a very unusual member of the *Protolabis-Pliauchenia* lineage. The Floridagulinae are now seen to have had a trans-coastal plain distribution. The Gulf Coast species of the Synthetoceratinae are discussed and the phylogeny of the subfamily outlined. The Gulf Coastal Plain constituted a distinct faunal province throughout most of the Tertiary, and several groups are true Gulf Coast autochthons. Some groups have species endemic to the Gulf Coastal Plain but also occur in the Great Plains. The ages of the Texas Gulf Coastal Plain faunas are revised and correlated with those from the Great Plains.—*from* Author's synopsis

03956 **Pearce, T. H.** Primary analcite in volcanic rocks from Alberta, Canada: Geol. Soc. London Proc., no. 1651, p. 204-207, illus., 1969.

The analcite-bearing rocks represent a small part of the Crowsnest volcanism. The present experimental evidence suggests that the analcite grew at a great depth (possibly as great as 15 miles), at a high H_2O, but at a moderate temperature. It was then rapidly transported to the surface under explosive volcanic conditions and quenched before the analcite could completely decompose, although locally some analcite is decomposed. Exposure at the surface under low-pressure-'high'-temperature conditions has discolored some of the analcite, and this discoloration may be reproduced in the laboratory. —Author's summary

03984 **Pearring, Jerome Richard.** A study of basic mineralogical, physical-chemical, and engineering index properties of laterite soils [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4648B, 1969.

04298 **Pease, D. S.; Anderson, J. U.** Opal phytoliths in *Bouteloua eriopoda* Torr.—Roots and soils: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 321-322, illus., 1969.

Identifications of phytoliths from *Bouteloua eriopoda* Torr. (black grama) roots were based on repetitive size and shape, low density, acid insolubility, and lack of crystallinity. Refractive index, and contents of water and SiO_2 support identification as opal. These distinctive rectangular phytoliths were the most commonly observed form in the A horizons of several soils and paleosols. —Authors' abstract

04129 **Peck, R. B.** Advantages and limitations of the observational method in applied soil mechanics: Géotechnique, v. 19, no. 2, p. 171-187, illus., 1969.

The observational method, used by Terzaghi in applied soil mechanics, often permits maximum economy and assurance of safety, provided the design can be modified as construction progresses. The essential features of the method are set forth and examples are given of its application. The observations must be reliable, must reveal the significant phenomena, and must be so reported as to encourage prompt action. The possibility of progressive failure may inntroduce a serious element of uncertainty. The potential for savings of time and money with sacrifice of safety is so great that every engineer who deals with applied soil mechanics needs to be informed of its principal features. —*from* Author's abstract

03781 **Pecora, William T.** New horizons in natural resources management: Prof. Geographer, v. 21, no. 2, p. 73-78, 1969.

The United States finds itself confronted with urban sprawl, polluted air and water, depleted soils, declining stocks of high-grade minerals, and a growing need for pure water. Realization of the need for effective management of our resources started centuries ago and has spread to millions of citizens. The geographer and geologist must work together more and more. The U.S. Geological Survey finds itself faced with new horizons, including ocean resources, coastal zones, space science applications, urban studies, new kinds of maps, and the national atlas. Geology and geography have drifted apart and they need to be brought together again.—ESL

Pelletier, Bernard R. *See* Lumsden, David N. 04036

04259 **Penley, H. Michael.** Aerial photographs in Virginia: Virginia Minerals, v. 15, no. 2, p. 13-17, illus., 1969.

The first airphotos in Virginia were taken of the Richmond area in 1862 from a balloon; since then vast amounts of research have perfected techniques and instruments. Most of the coverage in Virginia is vertical photos at a scale of 1:20,000. The regional aspects of geomorphology, stratigraphy, structural geology, and hydrogeology can be interpreted, and the photos are a vital tool in engineering geology. However it is difficult to locate an exact position on an airphoto because of radial distortion. A stereoscope is useful in interpretation, and comparing features on the photos with the same features on the ground is helpful also. Airphotos are available for about 90 percent of Virginia. —ESL

04230 **Perkampus, H. H.; Kortüm, K.; Bruns, H.** Calibration of fluorescence apparatus: Appl. Spectroscopy, v. 23, no. 2, p. 105-110, illus., 1969.

The calibration of a light detector for recording fluorescence spectra is described. In this connection the physical principles are thoroughly reviewed and disagreements in the literature are referred to. An example for a special application is discussed. —Authors' abstract

04166 **Persoz, Francis.** Évolution plutonique et structurale de la presqu'île d'Akuliaruseq, Groenland méridional [with English summ.]: Medd. Grönland, v. 175, no. 3, 202 p., illus., tables, geol. maps, 1969.

The Akuliaruseq area, southeast of Julianehaab, is underlain by granites and gneisses of the Canadian-Greenlandic shield. Geologic history is divided into five periods: (1) pre-Ketilidian basement; (2) Ketilidian, with deposition of supracrustal rocks later metamorphosed in the amphibolitic-granulite facies and migmatized; first period of basic intrusion; deformation and plutonism with granitization; (3) Kuanitic, second period of basic intfusion, with ultrabasic, then doleritic, dikes; (4) Sanerutian, with reactivation of granites and gneisses; vein pegmatitization and strong shearing; third period of basic intrusion, with gabbroic to granodioritic dikes; younger, autochthonous granites originated by intense potash metasomatism, intruded by basic dikes; emplacement of microgranites and hot mylonites; (5) Gardar, represented by dolerite dikes and many faults. —VMJ

04188 **Peterson, Donald W.** Geologic map of the Superior quadrangle, Pinal County, Arizona: U.S. Geol. Survey Geol. Quad. Map GQ-818, scale 1:24,000, sections, text, 1969.

Lower Precambrian schist exposed in the western part of the Superior quadrangle is overlain by a sequence of chiefly sedimentary upper Precambrian and Paleozoic rocks; diabase intrudes the Precambrian rocks and dioritic plutonic and hypabyssal rocks intrude the entire sequence. Conglomerate and lava and ash flows (Cenozoic) blanket older rocks in the eastern section. A complex network of faults belonging to two principal systems is best developed in the southwestern area. The most productive ore deposits are those of the Magma mine; chief ore minerals are chalcopyrite, bornite, enargite, tennantite, chalcocite, digenite, and sphalerite; principal gangue minerals are pyrite and quartz, and less common are carbonate minerals and hematite. —MCM

Peterson, Johannes B. *See* Hiss, William L. 03880

Peterson, M. N. A. *See* Boström, Kurt. 03899

04187 **Peterson, Warren L.** Geologic map of the Bardstown quadrangle, Nelson County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-825, scale 1:24,000, section, text, 1969.

The Laurel Dolomite in the Bardstown quadrangle has been widely quarried for agricultural lime, road metal, asphalt filler, concrete aggregate, and building stone; reserves are very large. Where the original thickness of the Laurel is preserved, about 15 feet of the dolomite occurs. —MCM

Petr, V. *See* Praus, O. 04149

03666 **Péwé, Troy L.; Church, Richard E.; Andresen, Marvin J.** Origin and paleoclimatic significance of large-scale patterned ground in the Donnelly Dome area, Alaska [with French, German, and Russian abs.]: Geol. Soc. America Spec. Paper 103, 87 p., illus., tables, 1969.

Large-scale patterned ground in central Alaska consists of polygons 25-46 m diam. bounded by shallow troughs 1-2 m wide, which are underlain by wedge-shaped masses of sediments that extend downward 2 to 3 m. Texture of the sediments of the wedges is distinct from that of the poorly stratified glacial-outwash gravel they transect, and varies along the strike and vertically within a given wedge. The pat-

terned ground originated during Wisconsin time; a polygonal network of thermal-contraction cracks formed during the winters and ice wedges grew in the permafrost. With post-Wisconsin warming, the voids created by melting of ice wedges were filled with sediment. The troughs bordering the polygons in this area are now underlain by ice-wedge pseudomorphs.—*from* Authors' abstract

03919 **Phillips, J. D.; Thompson, G.; VonHerzen, R. P.; Bowen, V. T.** Mid-Atlantic ridge near 43°N latitude: Jour. Geophys. Research, v. 74, no. 12, p. 3069-3081, illus., tables, 1969.

A reconnaissance bathymetric and magnetic survey of the Mid-Atlantic Ridge between lat 42° and 45° N. shows a symmetrical N-S magnetic pattern parallel to the axis over the two southernmost of six profiles. Basalts and relatively low heat flow characterize the southern area, and serpentinized peridotites and very high heat flow the northern area. The contrasting nature of magnetic, topographic, petrologic, and heat-flow character in the northern and southern areas suggests that the ridge crest at lat 43° N. is interrupted by a complex fracture zone. Model studies suggest that the configuration of magnetic bodies that could account for the symmetrical magnetic pattern of the southern area may be interpreted in terms of sea-floor spreading. A change in spreading rate is suggested to have occurred 4 m.y. ago.—*from* Authors' abstract

04213 **Philpotts, John A.; Schnetzler, Charles C.** Europium anomalies and the genesis of basalts—A reply [to 1969 discussion by D. G. Towell, R. V. Spirn, and J. W. Winchester, of 1968 paper]: Chem. Geology, v. 4, nos. 3-4, p. 464-465, 1969.

In response to a discussion of an original paper with the same title [ibid., v. 3, p. 5-13, 1968], it is averred that the anomalous behavior of europium is not due *only* to crystal chemistry effects. Towell, Spirn, and Winchester [ibid., v. 4, p. 461-464, 1969] partially misunderstood the purpose and content of the paper they discussed, the misunderstanding being duly ascribed to the poor writing of the authors, for which apologies are made, and appreciation extended to the critics for pointing out the confusing points and thereby permitting clarification. —HRC

03910 **Pickett, George R.** Principles for application of borehole measurements in petroleum engineering: Log Analyst, v. 10, no. 3, p. 22-33, illus., tables, 1969.

A general lack of papers on formation evaluation at the introductory level, and scattered, specialized technical literature prompted this "survey of the art" for the non-specialist; it is presented in general terms of useful applications in petroleum exploration and engineering, of which 14 are listed with available borehole measurements. The most common problem (determination of recoverable hydrocarbons), discussed with schematic relationships of permeability and porosity to saturation, includes use of empirical equations and choice of borehole measurements; determination methods and resistivity tools are tabulated. Illustrative examples are: a Miocene sand section of the U.S. Gulf Coast, a Minnelusa sand section of the Powder River basin, and Ordovician carbonates of the Williston basin.—GDC

04062 **Pilkey, Orrin H.; Blackwelder, Blake W.; Doyle, Larry J.; Estes, Ernest; Terlecky, P. Michael.** Aspects of carbonate sedimentation on the Atlantic continental shelf off the southern United States: Jour. Sed. Petrology, v. 39, no. 2, p. 744-768, illus., tables, 1969.

The abundance of $CaCO_3$ is mainly a function of the amount of dilution by terrigenous materials from Piedmont rivers. $CaCO_3$ is least abundant on the Georgia shelf and increases greatly to the south and slightly to the north. The abundance of black shells, oolites, and shallow water fauna over large portions of the shelf attest to the shallow water origin of much of the surficial material. The abundance of worn and broken shells reflects the low rate of sedimentation in this area. Much of the present-day shelf sediment cover was deposited in the nearshore zone of the last transgressing sea, but was not derived from the beach environment. The areal distribution of certain carbonate fraction parameters can be interpreted as linear patterns paralleling the present shorelines. These may reflect ancient shorelines. —*from* Authors' abstract

Pinson, W. H. *See* Brookins, D. G. 03858

04069 **Piper, David J. W.; Marshall, Neil F.** Bioturbation of Holocene sediments on La Jolla deep sea fan, California: Jour. Sed. Petrology, v. 39, no. 2, p. 601-606, illus., 1969.

The sediments of La Jolla fan comprise alternating beds of mud and sand. The muds and the upper parts of the sand beds are highly disturbed by burrowing animals. The amount of reworking in sand beds can be calculated from the degree of disturbance of the bed. The amount of reworking at the junction of the sand and mud beds is estimated by comparing observed distributions of sand-sized material in the sediment with distributions obtained by computer simulation of bioturbational processes. There appears to have been no marked changed in the intensity of reworking during the last 4000 years. Among individual burrow types recognized are those of the pelecypod *Nucula*, of a deep water echinoid, and ones formed by animals escaping through rapidly deposited sand beds. —Authors' abstract

Plant, M. G. *See* Crain, I. K. 04257

03954 **Plato, Phillip Alexander.** Predicting the movement of a radionuclide through the soil [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4687B, 1969.

03711 **Plebuch, Raymond O.; Hines, Marion S.** Water resources of Clark, Cleveland, and Dallas Counties, Arkansas: U.S. Geol. Survey Water-Supply Paper 1879-A, p. A1-A32, illus., tables, 1969.

Although some of the streams in the project area can furnish dependable water supplies without storage, the amount available can be increased by construction of reservoirs. Ground-water yields vary from 10 gpm in consolidated rocks in the Interior Highlands to 700 gpm in the Coastal Plain. Tertiary formations offer the best possibilities, the Sparta Sand being the best aquifer; however, quality varies greatly. Total water use in 1965 was about 6 mgd, slightly half of which was derived from surface-water sources.—*from* Authors' abstract

Plebuch, Raymond O. *See* Lamonds, A. G. 03712

03730 **Pojeta, John, Jr.** Pelecypods, Chap. C *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 15-24, illus., 1969.

The 19 pelecypod species named and described by G. H. Girty in 1910 from the Fayetteville Shale are figured for the first time. In addition, lectotypes are chosen for those species names based on syntypes, locality data are provided, and Girty's original descriptions are reproduced.—Author's abstract

04265 **Pollard, Charles O., Jr.** Second-rank tensor anion polarizabilities in some rutile group crystals: Jour. Physics and Chemistry Solids, v. 30, no. 5, p. 1251-1259, tables, 1969.

Straightforward computation of anion polarizability elements for light electric vector vibration parallel with, then normal to, the plane of three cations bonded to each anion in six rutile-group minerals yield values presented in rationalized units, and for lowest available visible refractive indices. The tetragonal character of these minerals precludes rigorous separation of the two elements for vibration normal to the cation plane and parallel to it, but normal to the c-axis. Their linear relation is solved by an approximation that improves as the three bond lengths approach equality. Of the six minerals reported, only cassiterite has all nearest-neighbor bond lengths essentially equal; hence anion polarizability values for it are more nearly rigorous than for the other minerals.—*from* Author's abstract

Post, Austin. *See* Meier, Mark F. 03940

03821 **Potter, Noel, Jr.** Tree-ring dating of snow avalanche tracks and the geomorphic activity of avalanches, northern Absaroka Mountains, Wyoming, *in* United States con-

tributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 141-165, illus., 1969.

The following criteria are used: datable scars on trees; changes in growth-ring pattern from concentric to eccentric, caused by tilting; changes in growth rate due to increase in photosynthesis when adjacent trees are destroyed; and age of trees within a given reforested avalanche track. The first two are the most reliable. Above the forest line, avalanche boulder tongues are formed over a period of many years by the accumulation of debris swept out of avalanche chutes. A peculiar linear feature on the surface of the tongues is the avalanche debris tail, which consists of fine debris that was deposited by large snow avalanches downslope 5 to 10 m from a large boulder. They are thought to be formed by a mechanism similar to that by which sand shadows are formed in the lee of obstacles in river channels or on desert dunes. —*from* Author's abstract

Pottratz, Steven W. *See* Abbott, Agatin T. 04124

04149 **Praus, O.; Petr, V.** Magnetotelluric calculations for the interaction of polarized fields with anisotropic layered media: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 759-769, illus., 1969.

Recurrence formulae for calculating impedance tensor elements of the magnetotelluric field at the surface of *N*-layer anisotropic medium have been derived and numerical results obtained for some specific models. Directional properties of impedance tensor elements, apparent resistivities, deviation angles from perpendicularity of magnetotelluric fields, and polarization characteristics are analyzed and their importance for the interpretation of magnetotelluric results is discussed.—Authors' abstract

03705 **Press, Frank.** The suboceanic mantle: Science, v. 165, no. 3889, p. 174-176, illus., 1969.

An independent determination of density in the suboceanic lithosphere gives 3.5 to 3.6 grams per cubic centimeter at a depth of about 100 kilometers. This high value implies the existence of an eclogitic facies. A mechanism is proposed in which eclogite fractionation from the underlying, partially molten asthenosphere plays a key role in the creation and the spreading of the rigid, lithospheric plate.—Author's abstract

04250 **Proctor, Cleo V., Jr.** The North Bosque watershed—Inventory of a drainage basin: Baylor Geol. Studies Bull., no. 16, 40 p., illus., tables, 1969.

The geomorphology of the four regions within this watershed is directly related to the properties of the rocks; a dynamic equilibrium exists between erosional energy and topography. Landforms are being wasted at the same rate, and differences in relief and form can be explained in terms of spatial relationships rather than evolutionary development through time. Sheet erosion is the major sediment producer, and the Paluxy Formation is the dominant contributor; the land is reduced by about 0.095 cm/year. Solution lowers the landscape by about 0.0012 cm/year. The watershed is in the erosional development stages of inequilibrium and equilibrium, and quantitative parameters indicate that Meridian Creek and Honey Creek basins are presently losing drainage in their headwaters to the Leon River. [Quantitative expressions are given for relations between geomorphology, hydrology, and erosional energy.] —*from* Author's abstract

Pullen, M. J. L. T. *See* Fulton, R. J. 04141

Raabe, R. G. *See* Ratté, James C. 03723

04252 **Raasch, Gilbert O.** Biostratigraphy and oil finding: Oilweek, v. 20, no. 6, p. 7, 10, illus., 1969.

Accurate dating of rock units becomes difficult as explorationists move away from a much-studied area. The one technique that can overcome the handicap of gaps in regional knowledge is biostratigraphy, which works in two planes, furnishing long range correlations, and subdividing the stratigraphic succession. Only through reconstructing the geography of the time can potentially productive features be located. Some of those discussed are: unconformities and permeability, subdivision of massive units, reefs and carbonate platforms, and uncovering buried topography. —ESL

04131 **Radinsky, Leonard B.** The early evolution of the Perissodactyla: Evolution, v. 23, no. 2, p. 308-328, illus., 1969.

The group radiated from the condylarths in the late Paleocene with 14 families appearing rapidly during the Eocene. The various factors responsible for the rapid radiation include differences in occlusial action in the molars of the major groups which appeared early (reflecting specialization for different food sources), and since some are sympatric, such division of niche resources is not surprising; size, however, could also be a factor. Secondary radiations occurred in the equoids, Brontotheroidea, Chalicotheroidea, Tapiroidea, and Rhinoceroidea. Parallelism in molar development in these groups is very evident; some convergence is also evident. The presence of large equoids and tapiroids in Europe during the Eocene may account for the absence of other large forms there. Artiodactyls may have successfully competed with perissodactyls in North America but not in Asia where the latter are large. —HRC

03921 **Raitt, R. W.; Shor, G. G., Jr.; Francis, T. J. G.; Morris, G. B.** Anisotropy of the Pacific upper mantle: Jour. Geophys. Research, v. 74, no. 12, p. 3095-3109, illus., tables, 1969.

Seismic refraction measurements of the compressional wave velocity of the upper mantle, obtained in the northeast Pacific Ocean between California and Hawaii, have shown a dependence on direction indicating anisotropy of velocity with a maximum of 8.6 kmps in a roughly easterly direction and a minimum of 8.0 kmps. Special anisotropy experiments were conducted at two locations. At each significant anisotropy was observed, agreeing in direction with the apparent anisotropy indicated for the entire region. The magnitude of the velocity difference, 0.3 kmps, on any single station is half the overall variation of 0.6 kmps. Although these observations do not prove the hypothesis of anisotropy throughout the entire region from California to Hawaii, they are consistent with it.—*from* Authors' abstract

Raitt, R. W. *See* Morris, G. B. 04032

Raleigh, C. Barry. *See* Carter, Neville L. 03885

03947 **Ralph, Elizabeth K.; Michael, Henry N.** University of Pennsylvania radiocarbon dates XII: Radiocarbon, v. 11, no. 2, p. 469-481, illus., tables, 1969.

This continuation of University of Pennsylvania list VII (1965) includes results for samples of *Sequoia gigantea* and for *Pinus aristata*, most of which were tree-ring dated at the Laboratory of Tree-Ring Research, University of Arizona. A table indicates amount of deviation of C-14 dates and dendro-dates for each sequential 500-yr period based on the 5730 half-life. The amount of deviation increases at an increasing rate during the 3,500 yr B.C. for which enough closely spaced, precisely dated tree-ring samples were processed. Adjustments have been made in positioning the radiocarbon dates in relation to "true" dates of tree-ring samples, the statistical treatment being an approximate one. Dates sampled are from California and Nevada. —MCM

Ramsey, Thomas R. *See* Hiss, William L. 03880

04044 **Randazzo, Anthony F.** Crystal molds in argillites of the Carolina Slate Belt, North Carolina: Jour. Sed. Petrology, v. 39, no. 2, p. 820-821, illus., 1969.

Voids resembling evaporite crystal molds were found in argillites of the Carolina Slate Belt, North Carolina. If interpreted correctly, they indicate that at least a portion of the Slate Belt was occasionally exposed to the atmosphere before lithification. —Author's abstract

03955 **Rankin, D.; Reddy, I. K.** A magnetotelluric study of resistivity anisotropy: Geophysics, v. 34, no. 3, p. 438-449, illus., 1969.

Apparent resistivity curves from magnetotelluric field measurements near Leduc, Alberta, reveal a strong anisotropy. The significance of the direction of the incident magnetic field in interpreting structure from apparent resistivity curves is examined in detail for the case of a linearly polarized incident field. Directions of principal axes of anisotropy are alined parallel to the north-south and east-west measuring axis. The two apparent resistivity curves are interpreted and an anisotropic layered model is derived. The anisotropy is found to lie in the Precambrian basement down to a depth of 14 km. The isotropic upper layer has a resistivity of 8 ohm-m which is characteristic of the sedimentary section. The anisotropic resistivity structure proposed for the basement may be attributed either to local lithological changes or to major but more distant structure. —*from* Authors' abstract

04150 **Rankin, Douglas S.; Ravindra, Ravi; Zwicker, David.** Preliminary interpretation of the first refraction arrivals in Gaspé from shots in Labrador and Quebec: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 771-774, illus., 1969.

Previous work in the Gulf of St. Lawrence has yielded an unusually high upper-mantle compressional velocity. In the Gaspé area a more recent determination has yielded a value of 8.75 ±0.20 km/sec for an unreversed profile. The arrival time at a station on the north shore of the St. Lawrence River suggests that there is no major difference in velocity and depth relative to the south shore. —Authors' abstract

Rasmussen, Lowell A. *See* Campbell, William J. 03926

04317 **Rathbun, Fred C.; Dickey, Parke.** Abnormal pressures and conductivity anomaly, northern Green River basin, Wyoming: Log Analyst, v. 10, no. 4, p. 3-8, illus., 1969.

Abnormally high formation pressures are present in the northern Green River basin, Wyo.; highest are found in the lower Tertiary-Upper Cretaceous interval in a belt along the front of the Wind River Mts. Somewhat lower pressures are on the west side of the basin in the Cretaceous Hilliar-Frontier-Dakota interval; pressures are near normal in the central part. A reversal of the slope of the conductivity plot is associated with abnormally high pressures. Mapping of the top of the conductivity slope reversal on a regional scale defines large areas which are suspected to be underlain by over-pressured shale sections. Distribution of these areas with respect to major tectonic elements (Wind River uplift and Wyoming overthrust belt) suggests that tectonism is the cause of abnormal pressures. —*from* Authors' abstract

03723 **Ratté, James C.; Landis, E. R.; Gaskill, David L.; Raabe, R. G.** Mineral resources of the Blue Range primitive area, Greenlee County, Arizona, and Catron County, New Mexico, *with a section on* Aeromagnetic interpretation *by* Gordon P. Eaton: U.S. Geol. Survey Bull. 1261-E, p. E1-E91, illus., tables, geol. map, 1969.

Rocks within and adjacent to the Blue Range primitive area in southeastern Arizona and southwestern New Mexico are volcanic or sedimentary clastic; a thickness of about 5,000 feet is exposed. Their age is mainly Oligocene and late Miocene, but some are Pliocene or younger; they are highly faulted and major faults define sets that trend NE, NW, and approximately west. Mineral-resource potential was appraised by geologic mapping, geochemical sampling, an aeromagnetic survey, and close examination of mining claims and areas of mineralized or altered rocks. No evidence of potential mineral resources was found in more than 90 percent of the area. The Squaw Creek-Maple Canyon area has a potential for molybdenum and copper. The likelihood of mineral-fuel deposits is slight; there are no mines and no records of mineral production.—*from* Authors' abstract

04081 **Rattew, Arthur R.** Helicopterborne electromagnetic, magnetic and radiometric survey, Coronation mine, Saskatchewan, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 301-320, illus., 1969.

The merits of combining a sensitive airborne magnetometer with an airborne electromagnetic unit are discussed. The magnetic data are considered very important in assessing conductors as prospects for commercial sulfide deposits in this area of numerous electromagnetic anomalies. This survey illustrates the value of EM in-phase measurements in detecting high-conductivity ore bodies and in providing diagnostic information concerning the geological nature of the conductors. Radiometric records are used to aid in the positioning of conductivity and magnetic anomalies and as an aid in interpreting the nature of certain conductors. —*from* Author's abstract

Ravindra, Ravi. *See* Rankin, Douglas S. 04150

03657 **Raymond, Gerald P.** Construction method and stability of embankments on muskeg [with French abs.]: Canadian Geotech. Jour., v. 6, no. 1, p. 81-96, illus., 1969.

A method for the design and construction of relatively thick highway embankments across muskeg deposits is described. Using theoretical soil-mechanics concepts it is predicted that the long-term stability of the muskeg necessitates the use of berms despite the fact that an undrained strength analysis based on in situ vane tests may predict a reasonable factor of safety. Consideration of both theoretical soil-mechanics concepts and practical considerations suggested that the interaction between the soil and the berm dictates that berm construction should be from the outer limits towards the center and should be placed prior to the central fill. Several case records are presented to support the conclusions drawn and furthermore suggest that the width of the berms should be 1 1/2 to 2 times the thickness of the muskeg (peat plus lake marl).—Author's abstract

Reddy, I. K. *See* Rankin, D. 03955

03692 **Reeburgh, William S.** Observations of gases in Chesapeake Bay sediments: Limnology and Oceanography, v. 14, no. 3, p. 368-375, illus., 1969.

Summer and winter depth distributions of Ar, N_2×CH_4, and total CO_2 are reported. Methane increased with depth from undetectable amounts at surface to 150-85 ml/liter in water depths of 30.4 and 15.2 m. Maximum values agree with calculated values assuming that CH_4 is controlled by ebullition from sediment. Argon and N_2 in surface sediments were present in concentrations near that of overlying water and decreased with depth to values of 0.1 and 2 ml/liter. Depth variation of N_2:Ar ratio indicate selective removal of N_2. Total CO_2 increased with depth to concentrations of 1,500 ml/liter and pH remained uniform with depth at about 7. Low values of total H_2S and an abundance of acid labile sulfides in sediments indicate that sulfide species are removed by mineral formation. All mixing is above 25 cm depth.—*from* Author's abstract

04308 **Reed, T. E.; McMurtrey, R. G.** Water levels and artesian pressures in observation wells in Montana through 1968: Montana Bur. Mines and Geology Bull. 71, 30 p., illus., tables, 1969.

This third annual water-level report for all permanent observation wells in Montana includes data for the years 1966-68 for 154 wells. The initial source of ground water is precipitation which varies widely; ground water occurs under a wide range of conditions. In some areas, aquifers yielding only a few gpm are of considerable importance, whereas in other sections where aquifers may yield several hundred gpm, formations yielding only small amounts may be classed as nonproductive. —MCM

Reeser, D. W. *See* Gulbrandsen, R. A. 03767

03901 **Reid, A. F.; Ringwood, A. E.** High-pressure scandium oxide and its place in the molar volume relationships of dense structures of M_2X_3 and ABX_3 type: Jour. Geophys. Research, v. 74, no. 12, p. 3238-3252, illus., tables, 1969.

Sc_2O_3 has been transformed at 1000°C and 130 kb from the relatively open C-rare-earth structure type to the monoclinic B-rare-earth form with unit cell dimensions a =13.173 A, b=3.194 A, c=7.976 A and β=100.40°. The calculated density, 4.16 g per cu cm, represents an increase of 8.3 percent over the density of C-type Sc_2O_3 and reflects an increase in coordination from six to seven fold for two-thirds of the Sc atoms. Dense structural forms are, in order of decreasing molar volume: defect spinel; C rare earth; garnet; rare-earth manganite; corundum; B rare earth; A rare earth; and perovskite. Very high-pressure Fe_2O_3 is probably a perovskite, and very high-pressure $MgSiO_3$ is probably an ilmenite. —*from* Authors' abstract

Rettig, S. L. *See* Jones, Blair F. 03818

Reynolds, G. William, Jr. *See* Dort, Wakefield, Jr. 04025

Rezak, Richard. *See* Bouma, Arnold H. 04217

Rich, C. I. *See* vonReichenbach, H. Graf. 04177

Richardson, Everett V. *See* Watts, Frederick J. 04276

Rieke, Herman H., 3d. *See* Chilingarian, George V. 03855

03883 **Rinehart, John S.** Thermal behavior of Solitary Geyser [abs.]: Colorado-Wyoming Acad. Sci. Jour., v. 6, no. 2, p. 29, 1969.

Ringot, J. *See* Allaud, L. A. 03925

Ringwood, A. E. *See* Reid, A. F. 03901

03782 **Ritchie, William A.** The earliest occupants—Paleo-Indian hunters (c. 8000 B.C.), [Chap.] 1 *in* The archaeology of New York State (2d edition): Garden City, N.Y., Natural History Press, p. 1-30, illus., revised, 1969; originally published 1965.

Earliest evidence of man in northeastern United States, represented chiefly by fluted points and camp sites, is considered in relation to late Wisconsin and early postglacial geochronology and the distribution of Pleistocene mammals. Excavations at several new sites in New York State since 1964, and research in surrounding areas, have added significant new data. Movements of the Early Hunters are traced by distribution of Clovis points in relation to the Port Huron moraines and the strandlines of glacial Lake Iroquois and the Champlain Sea; presence of the Clovis tradition in the Northeast during the time of the latter part of the Valders glacial substage has been confirmed in Nova Scotia by reliable radiocarbon dates averaging 8635 B.C. (Byers, 1966). Probable Plano points, of a later tradition, have been found in the Northeast, but not in New York.—VMJ

03843 **Rittenhouse, Gordon; Fulton, Robert B., 3d; Grabowski, Robert J.; Bernard, Joseph L.** Minor elements in oil-field waters, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 189-209, illus., tables, 1969.

Spectrochemical analyses of 823 oil-field waters are given. Concentrations range widely but commonly are: K and Sr, 100 + ppm; Al, B, Ba, Fe, Li, and Si, 1-100 ppm; Cr, Cu, Mn, Ni, Sn, Ti, and Zr, ppb (most waters); and Be, Co, Pb, V, W, and Zn, ppb (some waters). Cr, Li, Mn, Si, and Sr are commonly more than twice as abundant as in present sea water; Cu, K, Ni, and Sn are commonly less than half as abundant. Si content seems to vary between areas, between formations in the same area, and inversely with total solids content in the same formation. Other variation relationships were more difficult to establish because of concentration and equipment limitations. Changes in pH of many waters occur between collection and analysis, and because of this and changes between surface and subsurface, such quantitative interpretations will be difficult.—*from* Authors' abstract

04333 **Ritzma, Howard R.** Dahlgreen Creek test evaluated: Utah Geol. and Mineralog. Survey Quart. Rev., v. 3, no. 1, p. 1-2, illus., 1969.

The Shell Oil test well in Summit County, Utah, reached a total depth of 17,100 feet, penetrating the Dakota Formation and the top of the Jurassic Morrison Formation; there were 50 feet of oil-stained sandstone but the well did not produce. The very crooked hole bottomed mountainward beneath the fault overhang, nearly a half mile south of the surface location. A total of 8,790 feet of Precambrian were drilled in two sequences. Formations below 13,813 feet appear to be normal and undisturbed, but above that, all are topsy-turvy. The boundary of the Uinta Mtn. uplift is a zone of reverse faulting. A tentative section accompanies the log. —ESL

03783 **Robertson, W. A.** Magnetization directions in the Muskox intrusion and associated dykes and lavas [with French abs.]: Canada Geol. Survey Bull. 167, 51 p., illus., tables, geol. map, 1969.

Paleomagnetic results are given from 330 samples taken from 143 sites in the Muskox ultramafic intrusion, Coppermine lavas, and Mackenzie dikes [Northwest Territories]. Thermal and electromagnetic laboratory studies indicate the stability spectrum present. Significant magnetic compass deviations were observed at many ultramafic sites. Sequences of samples through layered rocks point to cyclic variations in the Earth's magnetic field like those in recent times. Paleomagnetic results suggest a deuteric origin for serpentine. Radiogenic ages place the Muskox and Mackenzie intrusions, and extrusion of Coppermine lavas in the Middle Proterozoic. Paleomagnetic results gave pole positions from five units, with the mean position in the Pacific and the equator passing through central Quebec.—*from* Author's abstract

03916 **Robin, G. de Q.; Barnes, P.** Propagation of glacier surges, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 969-976, illus.; discussion, p. 976-977, 1969.

Propagation of glacier surges has been discussed in terms of stresses acting in the three major zones of the surge. The steeply sloping front of a surge appears sufficient to explain the thickening of a glacier and the rise in velocity of ice motion which takes place across this zone in terms of accepted stress-strain rate data for ice. Explanation of the high velocities which occur in the next zone in spite of little change in the available shear stress is more difficult, but the experimental results of Barnes and Taboe on ice close to the melting point appear to offer an explanation of the unusually high rates of flow. In the tensile zone, where velocities slow down, the net lowering of the glacier surface after the surge has passed is explained in terms of the depth of crevassing and the easier flow of ice at melting point when under tensile and shear stresses.—Authors' abstract

03934 **Robin, G. de Q.** Initiation of glacier surges, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 919-926, illus.; discussion, p. 926-928, 1969.

Evidence of approximately equal volumes of ice being involved in repeated surges of the same glacier favors stress instabilities as the most likely cause. Surges originate when the nature of the glacier flow changes from extending to compressive flow. In the zone of accumulation a surge could be triggered by such a change over the length of the glacier. If the volume of ice and movement velocities involved are sufficiently large, this could lead to repeated surging, although a tendency to stability appears to exist. In the ablation zone, the lower part could act as a sliding dam and back the ice up the valley, and if volume and discharge reaches a limit, depending on bedrock, a surge could begin.—*from* Author's abstract

03975 **Robinson, John C.** HRVA—A velocity analysis technique applied to seismic data: Geophysics, v. 34, no. 3, p. 330-356, illus., 1969.

A High-Resolution Velocity Analysis (HRVA) has been developed which can be employed for the determination of the rms subsurface velocity energy spectrum from gated seismic data which has been NMO corrected. This technique is illustrated with West Texas seismic data. The results are discussed as a means for deriving a more accurate rms subsurface velocity function for NMO corrections and subsequent stacking, and as a means for various lithologic investigations. —*from* Author's abstract

04208 **Robinson, Paul T.** High-titania alkali-olivine basalts of north-central Oregon, U.S.A.: Contr. Mineralogy and Petrology, v. 22, no. 4, p. 349-360, illus., tables, 1969.

Flows of alkali-olivine basalt occur in the Oligocene to early Miocene John Day Formation. Fifteen specimens (44 to 48 percent SiO_2) have an average 3.6 percent TiO_2 and 15 percent total iron. These compare closely with the average hawaiite differing only in slightly more iron and slightly lower SiO_2 and total alkalis. Closely associated flows of trachyandesite and quartz latite are chemically related to the basalts and probably formed by differentiation of an alkali-olivine basalt magma. Differences in composition and age, and the lack of transitional varieties show these basalts to be unrelated to younger Columbia River basalts. They presumably represent a separate parent magma of alkalic affinity that was generated independently within the mantle. —*from* Author's abstract

03860 **Robinson, Peter; Jaffe, Howard W.; Klein, Cornelis, Jr.; Ross, Malcolm.** Equilibrium coexistence of three amphiboles: Contr. Mineralogy and Petrology, v. 22, no. 3, p. 248-258, illus., tables, 1969.

Electron probe and wet chemical analyses of amphibole pairs from the sillimanite zone of central Massachusetts and adjacent New Hampshire indicated that for a particular metamorphic grade there should be a restricted composition range in which three amphiboles can coexist stably. An example of a three amphibole rock has been found. It contains a colorless primitive clinoamphibole, like cummingtonite, with blue-green hornblende exsolution laminae; blue-green hornblende with primitive cummingtonite exsolution laminae; and pale pinkish tan anthophyllite that is free of visible exsolution lamellae but is a submicroscopic intergrowth of two orthorhombic amphiboles. Mutual contacts and coarse, oriented intergrowths of two and three host amphiboles indicate that the three grew as an equilibrium assemblage prior to exsolution.—*from* Authors' abstract

Robinson, Russell, *See* Kovach, Robert L. 04108

03917 **Roed, Murray A.** NWT basal sands inviting targets: Oilweek, v. 20, no. 21, p. 8, 10, illus., 1969.

A basal "Paleozoic" sand overlying Precambrian rocks along the western edge of the Canadian Shield is one of the most porous and permeable potential hydrocarbon reservoirs in the west, as well as being associated with major deposits of uranium, base metals and precious metals. Its genetic characteristics vary from place to place and it is called by different stratigraphic names, but can be treated as one unit; porosity and permeability characteristics favorable to oil entrapment are common to the unit, and thickness range of 200 to 600 feet is more than adequate. Recent field work and other investigations indicate that these sands, at least in Northwest Territories, must be potentially important exploration objectives, particularly in the Great Bear Plain and MacKenzie delta.—GDC

03716 **Ropes, Leverett H.; Morgan, Charles O.; McNellis, Jesse M.** FORTRAN IV program for synthesis and plotting of water-quality data: Kansas Geol. Survey Spec. Distrib. Pub. 39, 59 p., illus., tables, 1969.

The program synthesizes data for the U.S. Geological Survey's water-quality cards. Line-printer output consists of tables and two semilog graphs in which the distribution and the minimum, mean and maximum values of a selected group of data are given. The two graphs represent front and top orthographic projections of a three-dimensional array of data. The user selects (1) up to 16 variables, (2) data sorting according to multiple criteria such as aquifer and ranges of values of selected variables, (3) ion concentration units, (4) order of plotting, (5) log scale of the graphs, and (6) option of top-view graph. The program is operational on the Ge-635 computer at the University of Kansas Computation Center (program designation: ROPES) and the U.S. Geological Survey's IBM 360/65 program library disc (program designation: D0160).—Authors' abstract

03922 **Rose, William I., Jr.; Stoiber, Richard E.** The 1966 eruption of Izalco volcano, El Salvador: Jour. Geophys. Research, v. 74, no. 12, p. 3119-3130, illus., tables, 1969.

During October-November, 1966, 900,000 cm m of olivine basalt flowed from the flank of Izalco volcano, El Salvador. The total heat energy was approximately 10^{15} calories. No measurable changes in gravity occurred at stations on the active cone between August 1964 and August 1967. an the summit crater fumaroles have surface temperatures as high as 540°C. The cooling rate of these fumaroles was 18°C per year before the eruption and 45°C per year after. Yearly temperature cycles due to wet and dry seasons are superimposed on the general cooling trend. The rate of gas emission at four fumaroles in November 1967 was 86 g per sec. The data from fumaroles and the volume of the flank eruption indicate that the volume of the high-level magma storage beneath the crater was 3.8×10^8 metric tons before eruption and 1.4×10^8 metric tons after.—*from* Authors' abstract

Rosholt, J.N. *See* Szabo, B. J. 03908

Ross, Malcolm. *See* Robinson, Peter. 03860

04277 **Ross, Sylvia H.** Introduction to Idaho caves and caving: Idaho Bur. Mines and Geology Earth Sci. Ser. 2, 54 p., illus., 1969.

Most of the 200 recorded Idaho caves are lava tubes, lava blisters, or fissure caves in the basalts of the Snake River plain. Concentrations of known lava caves are near Mountain Home north of Bliss, in the Black Butte lava flow north of Shoshone, in the southern end of the Great Rift Zone northwest of American Falls, at Craters of the Moon National Monument, and in the northeastern corner of the plain. Of the relatively few solution-formed limestone caves, most are in the southeastern section, but the largest, Papoose Cave, is near Riggins in the west-central part. [This popular account includes examples of caves and general information on caving.] —*from* Author's abstract

Roth, Edward. *See* Dalquest, Walter W. 03809

04010 **Roy, J. L.; Opdyke, N. D.; Irving, E.** Reply [to comments by K. M. Creer on "Further paleomagnetic results from the Bloomsburg Formation" (1968)]: Jour. Geophys. Research, v. 74, no. 12, p. 3303, illus., 1969.

In the paper in question (ibid., v. 72, no. 20, p. 5075-5086, 1967) it was possible to explain all the data in terms of two magnetization events, one pre-Appalachian and possibly Silurian, and the other Kiaman. Creer's explanation (ibid., p. 3299-3302) requires four magnetization events; if 23 of the 32 intermediate samples represent a Silurian event, then three others are needed to explain the northerly group (77 samples), the southerly group (52 samples), and the remaining 9 intermediate samples. The simpler explanation is preferred.—DBV

04161 **Roy, J.L.** Paleomagnetism of the Cumberland Group and other Paleozoic formations [with French abs.]: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 663-669, illus., tables, 1969.

Red bed samples from the Pennsylvanian of Nova Scotia indicate that the fossil magnetization is composed mainly of thermally distributed (up to 650°C) magnetization. The direction changes between heatings is small, indicating magnetization in a field of constant polarity. The magnetization predates the folding which occurred shortly after deposition. The results (direction 172°, +16°; $k = 85$; pole 36° N., 125° E.) are compared with other results obtained from Paleozoic formations. Intercontinental comparison suggests that a 30° apparent polar change during the Paleozoic is probable. At least half of the change took place during the late Paleozoic and probably during the Pennsylvanian. —*from* Author's abstract

Roy, Robert F. *See* Warren, Robert E. 03964

Roy, Robert F. *See* Brune, James N. 04053

03780 **Rözkowski, A.** Chemistry of ground and surface waters in the Moose Mountain area, southern Saskatchewan: Canada Geol. Survey Paper 67-9, 111 p., illus., tables, 1969.

In this area, geology and geochemistry of sloughs and lakes as well as of hydraulically connected ground waters indicate some lithological and mineralogical differentiation of glacial deposits. Salinity of surface waters is high, but its variation and chemistry of the waters depend mainly on lithology and ground-water flow conditions. Distinguished by hydrochemical zones, the local and intermediate flow systems are more saline with SO_4-Mg in areas of discharge than in recharge and transmission areas; in the deeper regional ground-water flow system SO_4-HCO_3-Na or SO_4-Na appear. Physico-chemical processes induced by evaporation, ion exchange, and biological activity of aquatic plants modify the chemistry of slough and lake waters. These are discharge areas for local and intermediate ground-water flow only; the regional ground-water flow drains beyond the area of the Moose Mountain hills.—GDC

03748 **Rubenstein, Sam R.** Petrographic-physical relationship of rock in an upper Colorado River damsite: Assoc. Eng. Geologists Bull., v. 5, no. 2, p. 123-136, illus., tables, 1968 [1969].

At the Morrow Point damsite, the Precambrian rock showed elasticity was adversely affected by (1) poor locking of constituent grains, (2) low angle of foliation, and (3) large amounts of compressible minerals. Elasticity was also inversely affected by the varying absorption of the rock. The variably foliated rocks indicate a wide range in elasticity values ($0.65\text{-}5.08 \times 10^6$ psi). Strength (3,696 to 27,380 psi) was also affected by much the same properties but to a greater degree by direction of foliation. A small amount of pore space and microcracks indicated low absorption values (av. 1.2 percent). Absorption also varies inversely with seismic elasticity values. Mica (heavier than quartz) gave the rocks a slightly high specific gravity (av. 2.73) compared to an average granite (2.66).—*from* Author's abstract

Rubin, Meyer. *See* Grove, D. B. 03740

Ruch, R. R. *See* Kim, Stephen M. 03945

04163 **Rube, Robert V.** Quaternary landscapes in Iowa: Ames, Iowa, Iowa State Univ. Press, 255 p., illus., tables, geol. map, 1969.

This paper, in two parts, attempts to explain the landscapes as formed in the Pleistocene and Recent, tackling problems from geomorphologic and pedologic points of view. A recent school of thought, dynamic equilibrium, purports time-independence of things concerning the landscape; the present view shows the importance of time or time-dependence of processes giving rise to the landscapes and soils. By radiocarbon dating, these can be related in an absolute calendar. Part 2 includes a catalog of available radiocarbon dates in Iowa, and theoretical consideration of sample contamination. A Quaternary geologic map folded into back shows radiocarbon sites.—GDC

04157 **Russell, Dale A.** A new specimen of *Stenonychosaurus* from the Oldman Formation (Cretaceous) of Alberta: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 595-612, illus., tables, 1969.

A fragmentary skeleton of *Stenonychosaurus inequalis* indicates that this small theropod dinosaur is very closely related to *Saurornithoides mongoliensis* from the Cretaceous of central Asia. Both forms possessed relatively well developed cerebral hemispheres and large eyes, and were probably fleet bipeds with supple raptorial forelimbs. Their extreme rarity as fossils is attributed to their preference for environments not usually preserved in the stratigraphic record.—Author's abstract

Rust, Brian R. *See* Williams, Peter F. 04072

Rust, Brian R. *See* Brown, Richard L. 04152

Rutherford, M. J. *See* Arnold, R. G. 04088

03928 **Rutter, Nathaniel W.** Comparison of moraines formed by surging and normal glaciers, *in* Symposium on surging glaciers, Banff, Alberta, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 991-999, illus., tables, 1969.

A Neoglacial moraine of Bighorn Glacier, Yukon, probably formed by surging, and a Neoglacial normal moraine of Grizzly Glacier nearby, were studied. The surge moraine is thin, discontinuous, irregular mantle, mostly till, but including ice-contact stratified material. Lateral moraines show subdued ridges. The normal moraine is an irregular, continuous, thick mantle, mostly till and ice-contact stratified material. Upper ice limits are marked by prominent ridges. Rocks of similar lithologies are concentrated in bands parallel to the flow. In the surge moraine, stones are weakly oriented and strongly so in the normal moraine. Where orientation is present, it is not necessarily in the direction of flow. For the fraction finer than 2 mm, surge till is coarser than normal till although the bedrock terrain is similar.—*from* Author's abstract

04033 **Ryall, Alan; Savage, William U.** A comparison of seismological effects for the Nevada underground test Boxcar with natural earthquakes in the Nevada region: Jour. Geophys. Research, v. 74, no. 17, p. 4281-4289, illus., 1969.

Thousands of small aftershocks were recorded in the six-week period following the Boxcar underground explosion (m_b=6.42) on April 26, 1968. Most of the Boxcar aftershocks had a focal depth of less than about 5.5 km, which is shallower than predominant depths found for natural earthquakes in the Nevada region. Recurrence curves for the Nevada Test Site sequence had a b-value of 0.62, different from values of 0.79-0.84 for natural earthquakes in the region. A unique seismic event typified by emergent P arrivals, poorly defined S waves, low signal frequency, and long-duration surface waves, was observed. Differences between the Boxcar aftershock sequence and natural earthquakes in the Nevada region suggest that stresses due to the explosion may have been more significant than regional tectonic stresses in the generation of this aftershock sequence. —*from* Authors' abstract

Ryall, Alan. *See* Boucher, Gary. 04052

Ryder, Robert B. *See* Thomas, Mendall P. 03658

04099 **Sabina, Ann P.** Rocks and minerals for the collector—Buckingham-Mont-Laurier-Grenville, Quebec; Hawkesbury-Ottawa, Ontario: Canada Geol. Survey Paper 68-51, 107 p., illus., table, 1969.

Occurrences of rocks, minerals and fossils are described from over one hundred and fifty localities, which provide such potential ornamental types as feldspar, serpentine, marble, and granite. The best known area is the du Lièvre River valley where dumps of numerous apatite, mica, feldspar, and graphite mines still furnish good specimens of ore minerals and a variety of accessory minerals. Other deposits yield hematite, asbestos, barite and galena. Between Mont-Laurier, St-Jovite and Grenville, dumps of old mines and quarries contain ilmenite, graphite, garnet, serpentine, kaolinite, marble, granite, etc. Only serpentine and marble occur in specimens sufficiently large to be used for lapidary purposes. Ordovician limestones containing some fossils are exposed along highway, shoreline, and in quarries between Hawkesbury and Ottawa; these rocks are rich only in calcite minerals.—*from* Author'sabstract

04207 **Saint-Onge, D. A.** Nivation landforms: Canada Geol. Survey Paper 69-30, 12 p., illus., 1969.

The numerous rock types of Ellef Ringnes Island in the Queen Elizabeth Islands, N.W.T., makes it possible to study the influence of lithology on landforms resulting from the activity of a given process. Nivation, a combination of frost shattering, gelifluction and sheet wash, carves a series of landforms which vary according to the type of rock in which they occur. Lithology in determining debris size, controls the agents of removal and consequently the nature of the nivation landform. —Author's abstract

04175 **Salotti, Charles A.; Matthews, Vincent, 3d.** Quartz-leached graphic-granite from Monticello, Georgia: Southeastern Geology, v. 10, no. 3, p. 185-188, illus., 1969.

Quartz-leached graphic granite occurs within one of the zoned pegmatites in the Monticello pegmatite district, southwestern Jasper County, Georgia. The residual

feldspar is a dull pale pink maximum microcline. This microcline is generally unaltered but some microcline-void surfaces are coated with a thin layer of low albite and minor amounts of pale-green 3T muscovite. -Authors' abstract

Salvas, R. J. *See* DeLory, F. A. 04271

Sanchez, Florentino. *See* Bradshaw, R. L. 04012

03729 **Sando, William J.** Corals, Chap. B *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 9-14, illus., 1969.

Three coral species described by G. H. Girty in 1910 are illustrated for the first time. Lectotypes chosen from Girty's syntypes are redescribed. The taxonomy of *Michelinia meekana* Girty and *Palaeacis carinata* Girty remains unchanged, whereas *Menophyllum excavatum* var. *arkansanum* Girty is changed to *Zaphrentites arkansanus* (Girty).—Author's abstract

03772 **Sanford, Allan R.; Cash, Daniel J.** An instrumental study of New Mexico earthquakes, July 1, 1964, through Dec. 31, 1967: New Mexico Bur. Mines and Mineral Resources Circ. 102, 7 p., illus., tables, 1969.

This circular describes the natural seismic activity within or very close to New Mexico during the period from July 1, 1964, through December 1967. Origin times, locations, and magnitudes are listed for all earthquakes with magnitudes greater than or equal to 2.7. The most significant seismic event during the period of study was a magnitude 5.5 earthquake near Dulce on January 23, 1966. This earthquake (the strongest to occur in New Mexico for 28 years), with its aftershocks, accounts for more than half the total seismic activity during the 3.5 year period. The remaining activity was broadly distributed over the state, with the strongest shocks coming from the northeastern quadrant.—Authors' abstract

04228 **Sangrey, D. A.** Interaction of structures and foundations when subjected to repeated loading [abs.], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 223, 1969.

04031 **Savage, J. C.; Mohanty, B. B.** Does creep cause fracture in brittle rocks?: Jour. Geophys. Research, v. 74, no. 17, p. 4329-4332, illus., 1969.

The experiments of Brace, Paulding, and Scholz (1966) show that the dilatancy associated with triaxial compression of rocks is caused by microfractures in the rock. The microfractures do not, however, directly release the strain imposed by the external stresses. Rather, the external stresses apparently induce creep, which in turn produces internal (i.e. locked in) strain. It is the internal strain that is released by the microfractures. Thus, it would appear that in brittle rock, microfractures are caused by creep rather than creep being caused by microfractures, as suggested by Scholz (1968). —Authors' abstract

Savage, William U. *See* Ryall, Alan. 04033

04321 **Sawhney, B. L.** Regularity of interstratification as affected by charge density in layer silicates: Soil Sci. Soc. America Proc., v. 33, no. 1, p. 42-46, illus., table, 1969.

Sorption of Cs or K by most Ca-saturated vermiculites collapsed their alternate layers, producing regularly interstratified mica-vermiculite layer sequences. Sorption of Cs or K by montmorillonites did not collapse the layers readily and produced random, not regular, interstratification. The regularity of interstratification was related to the layer charge density of the minerals. —Editor's brief

04280 **Sayre, William W.** Dispersion of silt particles in open channel flow: Am. Soc. Civil Engineers Proc., v. 95, paper 6579, Jour. Hydraulics Div., no. HY 3, p. 1009-1038, illus., tables, 1969.

The dispersion process for sediment particles in a two-dimensional turbulent shear flow is formulated in two differential equations, one for particles suspended in the flow and the other for those deposited on the bed. Exchange of particles between bed and flow is permitted. Using Aris moment transformations, equations are converted to a more tractable system and solved by numerical methods with the aid of a digital computer for the zero'th, first, second and third moments of longitudinal concentration distributions. Various combinations of boundary and other input conditions are imposed and their effects on the dispersion process are demonstrated. Results of earlier dispersion experiments show that the tendency of the silt particles toward deposition and temporary storage on the bed can profoundly affect the longitudinal dispersion process. —*from* ASCE abstract

03953 **Schafer, Charles Thomas.** Distribution, pollution response, temporal variation of Foraminifera and sedimentation in western Long Island Sound and adjacent nearshore areas [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4734B-4735B, 1969.

Schlemer, E. W. *See* Schubel, J. R. 03682

Schleicher, David. *See* Lucchitta, Ivo. 03751

Schleicher, David. *See* Lucchitta, Ivo. 03752

04130 **Schmidt, Virginia.** When giant lizards lived: Desert, v. 32, no. 4, p. 35-37, illus., 1969.

Fossils from Ichthyosaur Paleontologic State Monument near Gabbs, Nevada are described briefly. —KAF

Schmitt, L. J., Jr. *See* Steven, T. A. 03724

Schnetzler, Charles C. *See* Philpotts, John A. 04213

Scholz, C. *See* Smith, S. W. 04007

Schopf, J. William. *See* Gutstadt, Allan M. 03699

Schramm, M. W., Jr. *See* Disney, R. W. 04302

03682 **Schubel, J. R.; Schlemer, E. W.** On the microscopic determination of the volume size distribution of fine-grained suspended particles: Limnology and Oceanography, v. 14, no. 3, p. 438-441, illus., 1969.

An apparatus and procedure are described whereby "all" of the suspended particles from a small volume of water and only the coarser particles from a larger volume of water are analyzed and the results combined. The appropriate volumes are dictated by the concentration of the suspended solids. A multipass filtering apparatus made of Delrin is loaded with a series of screens of different mesh size through which a measured volume of water is passed. The unit is flushed with distilled water, disassembled, and the screen discs stored until microscopic counting of the particles is made, some of which is done automatically.—HRC

04171 **Schufle, J. A.; Brassell, Gilbert.** Dating of Conchas River sediments, New Mexico: Nature, v. 223, no. 5213, p. 1356, illus., table, 1969.

Shell material from an interesting terrace along the Conchas River was dated by the ion exchange method; an age of 1,100 ± 200 yr was obtained. Charcoal and shells from the same deposit were dated by carbon-14 as 860 ± 120 and 765 ± 105 yr, respectively, the former being considered more reliable. The agreement of this date with the ion exchange date is reasonable. —DBV

03774 **Schultz, Gerald E.** Geology and paleontology of a late Pleistocene basin in southwest Kansas: Geol. Soc. America Spec. Paper 105, 85 p., illus., tables, 1969.

The Butler Spring Basin, near the Cimarron River in southern Meade County, is a sinkhole collapse basin that formed when subsurface solution of Permian evaporites caused collapse of overlying Pleistocene beds. There are four superimposed vertebrate faunas, including about 40 mammal species, here described. The Adams local fauna, Illinoian, includes large mammals in river sands and gravels. The three younger local faunas are in sinkhole sediments: the Butler Spring, late Illinoian, includes species of small mammals that do not range as far south today; the Cragin Quarry, of Sangamon age, includes diverse mammals and tortoises that indicate a warm, interglacial climate; and the Robert local fauna, late Wisconsin, consists of microvertebrates of marshes or low meadows; the climate probably resembled that of northeastern South Dakota today.—VMJ

03822 **Schumm, Stanley A.; Bradley, William C.** (editors). United States contributions to Quaternary research—Papers prepared on the occasion of the 8th Congress of the International Association for Quaternary Research, Paris, 1969: Geol. Soc. America Spec. Paper 123, 305 p., illus., tables, 1969.

This volume contains eleven papers (cited separately) dealing with various aspects of current Quaternary research. Normally they would have appeared in the Bulletin of the Geological Society of America but were reserved for this volume as contributions toward Quaternary research by American authors. Several are the results of Ph. D research, and several deal with landslides as an interesting application of Quaternary research to applied geology.—HRC

03838 **Schwarcz, H. P.; Agyei, E. K.; McMullen, C. C.** Boron isotopic fractionation during clay adsorption from sea-water: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 1-5, illus., tables, 1969.

Sea water is enriched in B-11 with respect to terrestrial and volcanic inputs. It is proposed that this is due to an isotope effect during adsorption of boron by clay minerals from sea water. An experimental test of this hypothesis using illite indicates a fractionation of about 30-40 per mille, enriching B-10 in the clay. This is in approximate agreement with a value calculated assuming that the ocean is at an isotopic steady state.—Authors' abstract

03665 **Schwarcz, Henry P.** Pre-Cretaceous sedimentation and metamorphism in the Winchester area, northern peninsular ranges, California: Geol. Soc. America Spec. Paper 100, 63 p., illus., tables, geol. map, 1969.

In this area, sedimentology and pre-intrusive metamorphism at the site of the Late Cretaceous Southern California Batholith are well preserved. Pelitic schists of the Jurassic (?) Bedford Canyon Formation are conformably overlain by a 13,000-ft-thick section of quartzite, schist, and amphibolite of the French Valley Formation (new name); relict sedimentary textures and structures indicate a marginal basin environment. The sedimentary rocks were intruded by basaltic sills, folded and regionally metamorphosed at low pressures and moderate to high temperatures, producing andalusite, cordierite, sillimanite, and garnet in the pelitic schists, and converting basic igneous rocks to garnet-diopside-amphibolites. The north-south trending boundaries of the four metamorphic zones bear no relation to distribution of plutonic intrusives of the batholith.—*from* Author's abstract

03714 **Schwarz, E. J.; Symons, D. T. A.** Geomagnetic intensity between 100 million and 2500 million years ago: Physics Earth and Planetary Interiors, v. 2, no. 1, p. 11-18, illus., table, 1969.

The decay of NRM of 146 specimens of igneous rocks during heating in steps of 25° or 50°C between 200° or 300°C and 550°C was compared to the acquisition of TRM during subsequent cooling to 20°C. The K-Ar ages of the specimens are between 100 m.y. and 2500 m.y. Results indicate that the mean equatorial geomagnetic intensity during most of the Phanerozoic and Precambrian eras as far back as 2.5 b.y. was 0.25 Oe with a standard deviation of 0.13 Oe. The dipole representation of the paleomagnetic field back to 2500 m.y. is not contradicted by variation of paleointensity with latitude. Thus, several characteristics of the present geomagnetic field were present as far back as 2500 m.y. ago.—*from* Authors' abstract

Sclater, John G. *See* Warren, Robert E. 03964

04080 **Scott, B. P.; Byers, A. R.** Trace copper and zinc in the Coronation mine overburden, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 291-299, illus., tables, 1969.

Podsol soil horizons developed on Pleistocene glacial sediments overlying the Coronation mine orebody were analyzed for copper and zinc spectrophotometrically, using biquinoline-isoamyl alcohol and dithizone carbon tetrachloride reagents. Copper and zinc are concentrated in the A_0 and C horizons, whereas the A_1, A_2 and B horizons are leached. Of economic significance is the fact that the C horizon contains a copper anomaly, in excess of 100 times background, directly over the orebody. Due to the erratic distribution of high copper concentrations in the A_0 horizon with respect to the orebody, that horizon is not considered as a reliable prospecting datum.—Authors' abstract

04269 **Scott, Glenn R.** General and engineering geology of the northern part of Pueblo, Colorado: U.S. Geol. Survey Bull. 1262, 131 p., illus., geol. map, 1969.

Pueblo is built on sedimentary deposits consisting partly of lithified sedimentary rocks and partly of surficial deposits. All lithified rocks, of which about 3,000 feet are exposed, are Cretaceous marine sediments. Quaternary surficial deposits are chiefly alluvium, but include eolian sand, colluvium, and artificial fill. Engineering problems that result from the behavior of the rocks in the northern part of Pueblo are chiefly those caused by low bearing strength, frost susceptibility of the fine-grained deposits, seepage of ground water, drainage of surface water, erosion susceptibility of newly made cuts, and reaction of hardened concrete to sulfate waters.—GRS

03951 **Segeler, Curt George; Greick, Irving W.** A field guide to Staten Island minerals: Staten Island Inst. Arts. and Sci. Proc., v. 24, no. 1, p. 7-25, illus., table, 1969.

This guide describes localities where interesting and sometimes rare minerals can be found on Staten Island; those in glacial driift are not included. Localities have been grouped according to geologic classification of the rocks in which the minerals occur and in general geographically from the northern to the southern end of the island: diabase, granites and schists, serpentine, magnetite, and artinite.—CM

03662 **Seiglie, George A.; Bermúdez, Pedro J.** *Tosaia lowmani*, a new species from off the Pacific coast of Panama: Cushman Found. Foram. Research Contr., v. 20, pt. 3, p. 96-98, illus., 1969.

Tosaia lowmani, n. sp., is described from Holocene sediments off the mouth of the Tapia River, Panama, at a depth of 5.6 m, where it makes up 33 percent of the total foraminiferal population of 10 benthonic species. The oldest species of the genus is *T. weaveri* Seiglie and Bermudez, 1966 (Miocene, Panama and Venezuela), from which evolved a deep-water species, *T. hanzawaia* Takayanagi, 1953 (Pliocene, Japan), and the shallow-water *T. lowmani*. Unlike the two older species, *T. lowmani* is differentiated into megalospheric and microspheric forms; it is also distinguished from the other species by its hispid surface and size differences.—VMJ

03869 **SenGupta, B. K.; McMullen, R. M.** Foraminiferal distribution and sedimentary facies on the Grand Banks of Newfoundland: Canadian Jour. Earth Sci., v. 6, no. 3, p. 475-487, illus., tables, 1969.

The southern part of the Grand Banks can be divided into three sedimentary regions. The northwestern is dominated by gravel-size material. The other regions are dominated by sand-size material. A large area of finer sediments occurs in the southwestern portion and shows a high density of foraminifera tests. On the Tail of the Bank, an inverse relationship is commonly present between density of benthonic tests and grain size of the sediments. The distribution of the planktonic foraminifera is controlled by the Labrador Current, the percentage decreasing rapidly on the shallow plateau, inward from the edge of the Bank.—*from* Authors' abstract

03794 **Sever, Charles W.** Hydraulics of aquifers at Alapaha, Coolidge, Fitzgerald, Montezuma, and Thomasville, Georgia: Georgia Geol. Survey Inf. Circ. 36, 16 p., illus., 1969.

Results of aquifer performance tests made on four well fields tapping limestones of Miocene, Oligocene, or Eocene age show that hydraulic properties vary greatly from one limestone aquifer to another in southwestern Georgia. Coefficients of transmissibility in the limestones ranged from 120,000 gpd per ft at Fitzgerald to perhaps 20,000,000 gpd per ft at Thomasville; coefficient of storage ranged from 0.00002 to 0.003. An aquifer performance test made on sand aquifers of Cretaceous age near Montezuma, shows the coefficient of transmissibility to be about 60,000 gpd per ft and the coefficient of storage to be about 0.002. Geophysical and lithologic logs and drawdown versus distance graphs made for the well fields should enable prediction of amount of interference between wells and also aid in determining proper construction and spacing of wells.—*from* Author's abstract

03977 **Shade, John William.** Hydrolysis equilibria in the system K_2O-Al_2O_3-SiO_2-H_2O [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4773B, 1969.

04116 **Shamsi, Sabiha; Stacey, Frank D.** Dislocation models and seismomagnetic calculations for California 1906 and Alaska 1964 earthquakes: Seismol. Soc. America Bull., v. 59, no. 4, p. 1435-1448, illus., 1969.

For earthquakes on fault planes whose horizontal dimensions are very much greater than the vertical directions, the assumption of infinite fault length allows the dislocation stress fields to be expressed by simple analytical equations. This facilitates an important generalization of the dislocation theory of earthquakes in which the fault displacement is graded to zero at the edges of the fault planes, thus avoiding singularities in the stress fields, which are still represented by straightforward analytical expressions. This development is necessary for realistic calculations of seismomagnetic anomalies, due to the piezomagnetic effect above the Curie point isotherm. Models which best fit the 1906 San Francisco and the 1964 Alaska earthquakes are given. Maximum total magnetic field anomalies for these models are respectively 2γ and 1γ per 10^{-3} emu of rock magnetization. —DBV

03769 **Sharps, Joseph A.** Lateral migrations of the Arkansas River during the Quaternary —Fowler, Colorado, to the Colorado-Kansas State line, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C66-C70, illus., 1969.

Former positions of the Arkansas River between Fowler, Colo., and Colorado-Kansas State line at given times during the Quaternary have been determined from the positions of terraces cut at those times. Lateral migration of the river during Quaternary time was probably caused by the introduction of a greater volume of sediment into the channel from one side than from the other. Gravel deposited by the Arkansas River differs from tributary gravel in composition and grain size.—Author's abstract

04313 **Shaw, Charles E., Jr.** Surficial geologic map of the Shrewsbury quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geol. Quad. Map GQ-794, scale 1:24,000, 1969.

Shaw, D. R. *See* Billings, Gale K. 03853

Shaw, G. *See* Brooks, J. 04103

Shedlovsky, J. P. *See* Cadle, R. D. 03727

03706 **Shepard, Francis P.; Marshall, Nell F.** Currents in La Jolla and Scripps submarine canyons: Science, v. 165, no. 3889, p. 177-178, illus., 1969.

Velocities of up to 34 centimeters per second have been recorded near the floors of submarine canyons off La Jolla, Calif. Currents move alternately down- and up-canyon with variable periods. All 3- to 6-day measurements show net current trans-

port down-canyon. Many of the down-canyon currents of higher velocity correlate with ebbing tides, as measured at the nearby pier. Other factors producing the currents probably include internal waves. Velocities are sufficient to transport large quantities of fine sand.—Authors' abstract

04242 **Sheppard, Richard A.; Gude, Arthur J., 3d.** Diagenesis of tuffs in the Barstow Formation, Mud Hills, San Bernardino County, California: U.S. Geol. Survey Prof. Paper 634, 35 p., illus., tables, 1969.

The Barstow Formation (Miocene) consists chiefly of lacustrine and fluviatile rocks. Lacustrine rocks are mainly mudstone with interbedded tuff and carbonate rocks. Altered vitric tuffs make up about 1/2 percent of the stratigraphic section. Zeolites, monoclinic potassium feldspar, silica minerals, and clay minerals now compose the altered tuffs. Zeolites are chiefly analcime and clinoptilolite, but local concentrations of chabazite, erionite, mordenite, and phillipsite have been found. Solution of silicic glass by moderately alkaline and saline pore water during early diagenesis provided the materials necessary for formation of zeolites. The zeolites, except analcime, formed directly from the glass by a solution-precipitation mechanism. Analcime seems to have formed from alkalic, silicic zeolite precursors. Potassium feldspar formed during later diagenesis from analcime and other zeolite precursors. —RAS

Sheridan, M.J. *See* Steven, T. A. 03724

Sherman, G.Donald *See* Walker, James L. 04126

04275 **Shih, Chia-Shun; Gloyna, Earnest F.** Influence of sediments on transport of solutes: Am. Soc. Civil Engineers Proc., v. 95, paper 6699, Jour. Hydraulics Div., no. HY 4, p. 1347-1367, illus., tables, 1969.

A mathematical model describing transport of radionuclides injected instantaneously in a stream is developed. Instantaneous release of dye was used to measure dispersion, and continuous release of Sr-85 to evaluate mass transfer coefficients. Aquaria and model river experiments determine parameters which define the sorption-desorption mechanism of radionuclides by sediments. Instantaneous injection of Sr into the model river provides data for correlating the analytical solution and a proposed mathematical model. FORTRAN programs are designed for analysis of gamma spectra, dispersion coefficients and transport equations. The mass transfer coefficient increases with increased velocity. Uptake of Sr by sediments may be high with increased temperature and presence of an organic pollutant. An exponential relationship is established between the Sherwood's and Reynold's numbers for the model river. —GDC

04018 **Shive, Peter N.** Dislocation control of magnetization: Jour. Geomagnetism and Geoelectricity, v. 21, no. 2, p. 519-529, illus., 1969.

Stress fields of edge and screw dislocations are analyzed to determine whether dislocations can exert independent magnetostrictive control over magnetization in magnetite. The stress-defined easy direction near a screw dislocation is described by a 45° helix or spiral about the dislocation line, although exchange and anisotropy energy suppress the spiral angle to less than 30°. The stress-defined easy directions near an edge dislocation are primarily normal to the dislocation line with a small region favoring magnetization parallel to the line. Single edge or screw dislocations cannot control magnetization independent from the surrounding domain, even in the absence of a demagnetizing field, although both types will produce local deflections of spins within a domain.—Author's abstract

04049 **Shive, Peter N.** The effect of internal stress on the thermoremanence of nickel: Jour. Geophys. Research, v. 74, no. 15, p. 3781-3788, illus., 1969.

In order to assess the influence of internal stress on magnetic properties of interest in paleomagnetic research, experiments were made on six strained samples from a nickel single crystal. The samples were disks 7.5 mm in diameter and 2.5 mm thick that were cold rolled to produce dislocation densities between 10^8 and 10^{11} per sq

cm. The intensities of weak field thermoremanent magnetization produced in the samples were proportional to their dislocation densities. Direct control of magnetization by stress fields near dislocations is shown to be energetically unfavorable, and a model is developed to explain relationships between remanence and dislocation density based on the pinning of domain walls. Some of the remanence remains after alternating field demagnetization in 400 oe, but possible higher stabilities are masked by a significant viscous component.—Author's abstract

Shor, G. G., Jr. *See* Raitt, R. W. 03921

Shor, G. G., Jr. *See* Morris, G. B. 04032

03764 **Silberman, Miles L.** Preliminary report on electron microscopic examination of surface textures of quartz sand grains from the Bering Shelf, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C33-C37, illus., 1969.

The surface textures of quartz sand grains from a dredge haul taken from a submerged ridge, 40 km north of St. Lawrence Island in the Bering Sea, were examined at magnifications of ×4,000 to ×13,000 using the electron microscope. The surface patterns, although etched by chemical solution, indicate that the deposit is of glacial origin and may have been modified by some marine reworking. This confirms the nature of the deposit inferred from other geologic features.—Author's abstract

Silverberg, Norman. *See* Stanley, Daniel J. 03848

03708 **Simmons, Gene; Nur, Amos.** Granitic rocks—Properties in situ [reply to discussion of 1968 paper by A. S. Orange, 1969]: Science, v. 165, no. 3889, p. 203, 1969.

In his criticism, Orange (ibid., p. 202-203) missed the significance of the paper by Simmons and Nur (ibid., v. 162, no. 3885, p. 789-791). Because of the difficulty in obtaining true resistivity of highly resistive rocks from electrical logs, they emphasized the change in electrical properties with depth rather than absolute values, which was much less than expected on the basis of previous laboratory data. Recent results reported by Thill and Bur (1969) on the effect of saturation on the St. Cloud gray granodiorite are similar to Simmons and Nur's observations on the Troy granite and show the dramatic effect of saturation on the electrical properties of another very low-porosity rock.—DBV

Simmons, Gene. *See* Chung, D. H. 03850

03890 **Simonett, D. S.** Aerial photo mosaic and radar imagery of Tuskahoma syncline; radar image of a breached synclinal fold, and of folded and faulted geologic structures, *in* Earth resource surveys from spacecraft, V. 2: Houston, Tex., Natl. Aeronautics and Space Adm., Earth Resources Group, p. E74-E77, illus. [1969?].

On the Tuskahoma syncline in southeastern Oklahoma, the cultural and vegetal detail tend to mask the major geologic features on a photomosaic, whereas structural trends are clearly defined on the radar image. Another radar image at the east end of the syncline shows six geologic units that can be mapped, and a third, northwest of the syncline, displays geologic structures. A major thrust fault separates two synclines in the north.—ESL

Simons, Daryl B. *See* Watts, Frederick J. 04276

04182 **Sinclair, A. J.; Libby, W. G.** Distribution of major minerals in a stock of Nelson plutonic rock, south-central British Columbia [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 40-46, illus., tables, 1969.

A quartz monzonite stock, centered about Mt. Carlyle in West Kootenay district, intrudes the Triassic Slocan Group. Trend surfaces from first to fourth order were established from plagioclase, K-feldspar, quartz, and total mafic minerals modal data and from specific gravity values. Plagioclase and K-feldspar values vary systemati-

cally; quartz and total mafic minerals have more erratic distributions. Linear trend surfaces show an increase of K-feldspar toward the southwest and a decrease in plagioclase and specific gravity; data are consistent with an hypothesis of Ca-enrichment from assimilation of more calcareous country rock north and east of the stock compared with more siliceous to the south and west. Peripherally high plagioclase and low K-feldspar linear residual values may be related to differentiation during progressive crystallization. —*from* Authors' abstract

04236 **Siple, George E.** Salt-water encroachment of Tertiary limestones along coastal South Carolina [with French abs.]: South Carolina Div. Geology Geol. Notes, v. 13, no. 2, p. 51-65, illus., reprinted 1969; originally published 1967.

This paper was published in 1967 *in* Hydrology of fractured rocks—Dubrovnik Symposium, 1965, Proc., V. 2: Internat. Assoc. Sci. Hydrology Pub. 74, p. 439-453. *See* Abstracts of North American Geology for October 1968.

04310 **Smith, A. Y.; Lynch, J. J.** Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys—No. 11, Uranium in soil, stream sediment and water: Canada Geol. Survey Paper 69-40, 9 p., tables, 1969.

Analytical methods used to determine trace quantities of uranium in soil, stream sediment and water are described. These techniques have been tested and used successfully in mobile field laboratories as well as in the headquarters laboratory. —Authors' abstract

04091 **Smith, J. R.** Nickel, copper and zinc in bedrock of the Coronation mine area, Saskatchewan, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 137-154, illus., table, 1969.

Ni, Cu, and Zn were determined in 1,500 samples of bedrock from a 32 sq mi area. Concentrations in thick bodies of metagabbro are distinctly different from those in basic metavolcanic rocks, and are consistent with genetic relationships between ultrabasic rocks and metagabbros, which were probably emplaced after folding and foliation of the volcanic rocks. The Cu distribution suggests epigenetic enrichment of permeable zones near the intersections of the two rock types with transcurrent, northeasterly faults which may be related to aeromagnetic maxima within large granodiorite complexes. The latter are postulated as the source of the hydrothermal solutions which caused the enrichment of the Cu in country rock, deposited numerous nearly barren sulfide bodies, and perhaps deposited the mineable sulfide bodies. —*from* Author's abstract

Smith, James W. *See* Milici, Robert C. 04224

04240 **Smith, James W.** Isotopic dating and metamorphic isograds of the crystalline rocks of Georgia, *in* Precambrian-Paleozoic Appalachian problems: Georgia Geol. Survey Bull. 80, p. 121-139, illus., table, 1969.

Dates on micas are, in general, about 350 m.y. on the northwest side of the Georgia crystallines and 250 m.y. on the southeast. Metamorphic isograds of the crystallines form a simple pattern, indicating a metamorphism period spanning both Acadian and Alleghanian orogenies. The two westernmost mica dates are older than 350 m.y. and may be from Precambrian rocks with micas reset below recrystallization temperature, or dates are time or times of intrusion or metamorphism near the Ordovician-Silurian boundary and in the Devonian. Five new K-Ar dates are given. Zircon dates from a granite and granite gneiss are about 450 m.y., which is highly suggestive of Taconic granitic intrusion and/or granitization but may reflect some other thermal event. Future dating projects in the area are outlined. —*from* Author's abstract

Smith, Joseph V. *See* Newton, Robert C. 04209

Smith, R. M. *See* Twiss, P. C. 04319

04007 **Smith, S. W.; McGinley, J., Jr.; Scholz, C.; Johnson, L.** Effects of large explosions on tectonic strain: Jour. Geophys. Research, v. 74, no. 3308-3309, 1969.

It is shown that significant tectonic stress changes associated with large explosions are confined to distances certainly less than 100 km and perhaps include only that volume around the source that undergoes nonlinear deformation during the explosion. —DBV

04111 **Smith, Stewart W.; VandeLindt, William.** Strain adjustments associated with earthquakes in southern California: Seismol. Soc. America Bull., v. 59, no. 4, p. 1569-1589, illus., table, 1969.

A technique for the calculation of strain changes in a two-dimensional elastic body with arbitrary internal dislocations is presented. This technique is applied to the southern California region by assigning a specific fault and fault slip function for each major earthquake that has occurred since 1812. Although the model used has serious shortcomings when applied to the real Earth, certain important features concerning strain energy changes associated with earthquakes are brought out. The occurrence of earthquakes over the past 150 years has resulted in net increases in stored strain energy in a number of regions including the northern end of the Gulf of California, the Cajon Pass area, and the northern part of the Carizzo Plain. Large regions of strain energy decrease can also be seen, the most important of which is in the vicinity of Fort Tejon. —Authors' abstract

Snyder, J. Herbert. *See* Moore, Charles V. 03863

03733 **Sohn, I. G.** Ostracodes, Chap. F *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 41-55, illus., 1969.

Twelve of the 13 ostracode species that were described without illustration by Girty are illustrated and redescribed. The generic assignments of four species are based on topotypes. The hinge of *Glyptopleura* is described and illustrated from serial acetate peels and dissection of carapaces. The species are referred to the following genera: *Amphissites, Bairdia, Geisina,, Glyptopleura, Graphiadactyllis, Kirkbya,, Orthobairdia, Paraparchites,, Roundyella, Sansabella,* and *Serenida.*—Author's abstract

04239 **Spalvins, K.** Stratigraphy of the Conasauga Group in the vicinity of Adairsville, Georgia, *in* Precambrian-Paleozoic Appalachian problems: Georgia Geol. Survey Bull. 80, p. 37-55, illus., 1969.

The mapped portion of the Adairsville quadrangle is located in the Valley and Ridge province of northwest Georgia. The Conasauga Group was divided and mapped on the basis of stratigraphic position and lithology. The units are the Maryville Limestone, Nolichucky Shale, and the Maynardville Formation. The major structure is an overturned anticline with a reverse fault near its southern end. All three units have economic potential. Most of the Maryville Limestone is a marginally potential cement grade material. The Nolichucky Shale is brick, quarry tile, and roofing tile material. The Maynardville dolostone has served as a crushed rock source. —Author's abstract

03787 **Spencer, Edgar W.** Introduction to the structure of the Earth: New York, McGraw-Hill Book Co., 597 p., illus., tables, 1969.

This book for an introductory structural geology course presupposes students are familiar with principles of physical and historical geology and have a working knowledge of algebra and plane geometry. Chapter headings are: concepts of stress and strain; theory of rock failure (fractures); faults; behavior of materials; folds and folding; cleavage, mullion, rodding, kinks, and boudinage; primary sedimentary structures; structures in unconsolidated sediment and salt; Earth's interior and major crustal elements; North American continental craton and its stable margin; base study of an orogenic belt (Alps); anatomy of a folded mountain belt (Appalachians); structural features of the North American cordillera; structural features of the ocean basins; examples of modern diastrophism; and tectonic syntheses.—MCM

Spirn, Regina V. *See* Towell, David G. 04212

04105 **Srivastava, Satish K.; Binda, Pier L.** Megaspores of the genus *Balmeisporites* from the Upper Cretaceous of Alberta and Saskatchewan, Canada [with French abs.]: Rev. Micropaleontologie, v. 11, no. 4, p. 205-209, illus., 1969.

Three new megaspore species of *Balmeisporites* are described and figured: *B. canadensis and B. dettmannii* from the Edmonton Formation of southern Alberta, and *B. kondinskayae* from the Whitemud Formation, Cypress Hills, Saskatchewan. The formations are Maestrichtian in age (except for the basal part of the Edmonton, which is late Campanian). *B. bellus* Kondinskaya 1966, originally found in western Siberia, also is described from occurrences in the Edmonton and Whitemud, to illustrate details of exospore structure not well shown in the original figures. Recorded occurrences of 10 additional species of the genus are listed. —VMJ

Stacey, Frank D. *See* Shamsi, Sabiha. 04116

03837 **Stacey, J. S.; Delevaux, M. E.; Ulrych, T. J.** Some triple-filament lead isotope ratio measurements and an absolute growth curve for single-stage leads: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 15-25, illus., tables, 1969.

Triple-filament analyses of three standard lead samples are used to calibrate a mass spectrometer in an absolute sense. The bias measured is 0.0155 percent per mass unit, and the precision is ±0.13 percent or less for all ratios relative to Pb-204. The triple-filament method is less complex and is an attractive alternative for smaller sample sizes down to 500 μg. Triple-filament data are presented for six possibly single-stage lead ores and one feldspar. These new data for ores are combined with corrected tetramethyl data for stratiform lead deposits to compute absolute parameters for a universal single-stage lead isotope growth curve. Absolute values for lead isotope ratios for all interlaboratory standard samples presently available from the literature are tabulated.—*from* Authors' abstract

03876 **Stacey, R. A.; Stephens, L. E.** An interpretation of gravity measurements on the west coast of Canada: Canadian Jour. Earth Sci., v. 6, no. 3, p. 463-474, illus., tables, 1969.

The survey includes parts of the Insular Tectonic belt and the Coast Ranges igneous and metamorphic complex as well as offshore. The major features are: a positive Bouguer anomaly along the western edge of the area, associated with the change from continental to oceanic crust, and a negative anomaly along the Coast Ranges which is attributed to the thickening of the continental crust below. On the eastern side of Queen Charlotte Islands, Hecate Strait, Queen Charlotte Sound, and Vancouver Island the average Bouguer anomaly is approximately zero, with local anomalies superimposed on a fairly flat gravity field. Several of these local anomalies are related to density variations in the surface rocks.—*from* Authors' abstract

04327 **Stalker, A. MacS.** Quaternary stratigraphy in southern Alberta—Rept. 11, Sections near Medicine Hat: Canada Geol. Survey Paper 69-26, 28 p., illus., tables, 1969.

This paper reviews results of studies of representative Quaternary sections at three bluffs along South Saskatchewan River, chosen because of their many similarities which suggested the possibility of intercorrelation, and because certain of their beds contain many fossil bones. One of the beds also yields stones that appear to have been worked by man. Although this report deals chiefly with glacial geology, all age determinations beyond range of radiocarbon dating are based on vertebrate paleontology. The beds apparently range from Kansan to Recent in age, and record at least four separate glacier advances and several interglacial or interstadial intervals. Abundant fauna of the unit containing the chipped stones indicates deposition during warm, interglacial conditions, probably in Sangamon time. Basal Kansan gravels also contain many bones, as do presumed mid-Wisconsin deposits found between the topmost two tills. —*from* Author's abstract

03848 **Stanley, Daniel J.; Silverberg, Norman.** Recent slumping on the continental slope off Sable Island bank, southeast Canada: Earth and Planetary Sci. Letters, v. 6, no. 2, p. 123-133, illus., 1969.

Large U- and V-shaped submarine valleys and intervening ridges on the continental slope southeast of Sable Island bank are only partially veneered with late Pleistocene to Holocene gray-pale olive green silty clay. Older Pleistocene reddish-brown mud-sand-pebble admixtures locally crop out in the vicinity of dissected topography. The scalloped slope topography, lack of continuation of some major slope valleys onto the lower rise, and exposures of Pleistocene units reflect important mass-gravity activity in this area during the Quaternary. Broad mounds that form the lower termination of the valleys, some of them covering more than 25 km², are probable toes of enormous subaqueous gravity slides of Pleistocene or older age. Cores penetrating contorted, mixed Pleistocene and Holocene glacio-marine sediments indicate that slumping has continued until recent time.—Authors' abstract

04019 **Staplin, Frank L.** Sedimentary organic matter, organic metamorphism, and oil and gas occurrence: Bull Canadian Petroleum Geology, v. 17, no. 1, p. 47-66, illus., table, 1969.

Hydrogen-rich material, amorphous translucent debris produced under sapropelic conditions, may form liquid and 'wet' gaseous hydrocarbons through compaction and temperature elevation. Thermal metamorphism of organic matter locked in sedimentary rocks, as well as mobile products, leads to paraffinic oils and condensates, then dry gas and pyrobitumens, and, under severe conditions graphitization: For a mapping index, five progressive degrees of thermal alteration are distinguished. Under the two highest, prospects for wet gas and liquid hydrocarbons are negligible without post-thermal migration from outside; the highest degree reduces prospects even for dry gas. On this basis Devonian dry gas in northern British Columbia is interpreted. Many areas with large dry-gas reserves were exposed to low-grade thermal metamorphism.—*from* Author's abstract

Stauffer, M. R. *See* Wardlaw, N. C. 04156

04295 **Stehli, Francis G.** Paleoecological reconstruction of depositional environments—Some techniques of possible exploration interest [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 96-97, 1968 [1969].

03791 **Stephens, John C.** Peat and muck drainage problems: Am. Soc. Civil Engineers Proc., v. 95, paper 6603, Jour. Irrigation and Drainage Div., no. IR 2, p. 285-305, illus., 1969.

With drainage of organic soils the surface is lowered by shrinkage due to drying, loss of ground-water bouyancy, compaction, wind erosion, burning, and biochemical oxidation. Relative effect of each of these depends on soil origin, land management, and climate. Total subsidence rate is proportional to depth of drainage—the lower the water table, the greater the soil loss. In the Florida Everglades largest losses have been due to biochemical oxidation; soils may become too shallow for agriculture by the year 2000. Drainage has permitted sea water to intrude the Biscayne aquifer and changed the ecology of the Everglades area to the detriment of wildlife. Subsidence of organic soils with drainage occurs worldwide with annual rates up to 3 inches. For maximum use, drain only potentially arable lands and hold water tables as high as crop and human requirements permit.—*from* Author's abstract

Stephens, L. E. *See* Stacey, R. A. 03876

03724 **Steven, T. A.; Schmitt, L. J., Jr.; Sheridan, M. J.; Williams, F. E.** Mineral resources of the San Juan primitive area, Colorado, *with a section on* Iron resources in the Irving Formation *by* Jacob E. Gair *and* Harry Klemic: U.S. Geol. Survey Bull. 1261-F, p. F1-F187, illus., tables, geol. map, 1969.

Geologically, the San Juan primitive area is divisible into a Precambrian terrane of metamorphic and igneous rocks in the west, and a Tertiary volcanic plateau in the east. Paleozoic and Mesozoic sedimentary rocks are exposed along the south margin, and extend under the volcanic rocks in the eastern part of the area. Mineral deposits of economic or near economic value are limited to: disseminated molybdenite in a Tertiary stock and metalliferous veins in the surrounding Precambrian granite in the Needle Mountains mining district; metalliferous veins cutting Precambrian

metamorphic rocks in the Whitehead Gulch area; gold-telluride veins in Precambrian quartzites and slates in the Beartown mining district, and native sulfur deposits in altered Tertiary volcanics in the Trout Creek-Middle Fork Piedra River area.—TAS

Stoertz, George E. *See* McKelvey, V. E. 03725

Stolber, Richard E. *See* Rose, William I., Jr. 03922

04323 **Stone, Donald S.** Wrench faulting and Rocky Mountain tectonics: Mtn. Geologist, v. 6, no. 2, p. 67-79, illus., 1969.

Block diagrams help to show that both vertical separation and an important component of vertical slip must accompany lateral movement along wrench faults. Reversal of fault dip along a fault line, en echelon parafolds or pinnate tension fractures, and abrupt stratigraphic changes across the fault zone are indicative. In the central Rocky Mountain foreland, many of these features can be seen along major west-northwest and northeast trending fault zones. Considering the north-south orientation of primary folds and low-angle thrust faults of the disturbed belt, it appears that a single NNE-SSW direction of principal horizontal stress can account for all of the Laramide structural features of this foreland. An idealized diagram and regional tectonic map show the writer's interpretation according to the wrench fault concept. Characteristic features are listed to aid in identifying other wrench fault zones of possible economic importance. —*from* Author's abstract

03709 **Stoneley, R.** Hugo Benioff [d. 1968]: Royal Astron. Soc. Quart. Jour., v. 10, no. 2, p. 164-165, 1969.

04142 **Storer, John E.** An Upper Pliocene Neohipparion from the Flaxville Gravels, northern Montana: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 791-794, illus., 1969.

Neohipparion sp. from the Flaxville Gravel of Sheridan County, northern Montana, compares well with late Hemphillian species of *Neohipparion* in height of crown, shape of protocone, and development of pli caballin. A late Hemphillian age conflicts with the Barstovian or Clarendonian age suggested by Collier and Thom's original evidence. The part of the Flaxville Gravel considered differs greatly in age from the nearby Wood Mountain Gravel of Saskatchewan, although it may be comparable in age with the Hand Hills Gravel of Alberta. —Author's abstract

03814 **Stout, Martin L.** Radiocarbon dating of landslides in southern California and engineering geology implications, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 167-179, illus., 1969.

One slide, just east of the Portuguese Bend slide, overran alluvium containing wood fragments; the radiocarbon age of the wood is 2915 ±205 yr B.P. The slide mass and scarp show minor erosion with rills and channels about 3 feet deep, and at least 25 feet of clay and silt have been deposited in the tension cracks at the head of the slide. Another slide, in Orange County, overran brush on the lower valley slope which is 17,180 ± 750 yr B.P. Tributary valleys more than 40 feet deep have been eroded in the slide debris, and more than 35 feet of sandy and silty alluvium have been deposited against the toe. Movement of the San Juan Capistrano landslide is correlated with the maximum late-Wisconsin low stand of sea level, about 17,000 to 20,000 B.P.—*from* Author's abstract

Stuart, D. J. *See* Iyer, H. M. 04039

03948 **Stuiver, Minze.** Yale natural radiocarbon measurements IX: Radiocarbon, v. 11, no. 2, p. 545-658, tables, 1969.

The present list represents a major portion of the samples measured since publication of the last date list in 1963 on: C-14 variations in tree rings (Arizona); investigations of samples of manufactured iron; lake sedimentation rate studies (Connecticut,

Taiwan, Uganda); geologic samples (North America, South America, Europe, Asia, Africa); archeologic samples (North America, West Indies, South America, Europe, Asia, Africa); and oceanographic samples (North and South Atlantic, and Antarctic Oceans).—MCM

Suess, Erwin. *See* Twiss, P. C. 04319

Suess, Hans E. *See* Arnold, James R. 04262

Suffel, G. G. *See* Darling, Richard. 04146

Suhr, N. H. *See* Ondrick, C. W. 04214

Suhr, N. H. *See* Ondrick, C. W. 04231

Supko, P. R. *See* Ball, M. M. 03698

Sutherland, Berry. *See* Blatt, Harvey. 04068

Suzuki, Nobuko. *See* Kigoshi, Kunihiko. 03941

03886 **Suzuki, Toru; Yokoyama, Takeo.** On the geophysical prospecting of overseas metal mines—Pt. 4, Case history of an induced polarization method on "porphyry copper" type deposits in British Columbia, Canada [in Japanese with English abs.]: Butsuri-Tanko, v. 21, nos. 5-6, p. 297-304, illus., 1969.

Induced polarization surveys of several properties in British Columbia in 1966-67 have shown that the method is efficient for locating porphyry copper deposits in contrast to difficulties encountered with the apparent resistivity method. Induced polarization surveys of porphyry copper deposits in Canada are much more effective than in Japan because of the larger target, shallow overburden, lack of argillization of rocks, and lack of pyrite around ore deposits.—VSN

Svoboda, G. R. *See* Keech, C. F. 03671

04312 **Swadley, W. C.** Geologic map of the Verona quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-819, scale 1:24,000, text, 1969.

Ground water in the Verona quadrangle is hard to very hard; wells drilled in valley bottoms can yield 100-500 gpd, but those drilled on hillsides generally yield no water. Shale of the Kope Formation slumps readily when wet. —MCM

04119 **Sylvester-Bradley, P. C.** Aluminum coating in scanning electron microscopy: Micropaleontology, v. 15, no. 3, p. 366, 1969.

In the scanning electron microscopy of microfossils, aluminum plating is preferable to gold because aluminum is more easily removed. —Author's abstract

Symons, D. T. A. *See* Schwarz, E. J. 03714

04160 **Symons, D. T. A.** Paleomagnetism of four late Miocene gabbroic plugs in south-central British Columbia: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 653-662, illus., tables, 1969.

Paleomagnetic studies were made of 101 cores from 20 sites representing 4 small olivine gabbro plugs in undisturbed Miocene plateau basalts in the Cariboo region. The mean site directions are significantly distinct within each plug. Both Tin Cup Mountain and Lone Butte plugs have normally polarized remanence, whereas Mount Begbie and Forestry Hill plugs have reversely polarized remanence. These plugs were emplaced over a short geologic span (less than one m.y.) and three polarity intervals are represented. The pole position (146.7° W., 84.9° N.) for the plugs is almost coincident with that of the surrounding basalts and is consistent with those obtained for other Miocene formations, and supports the hypothesis that the plugs represent the original vents from which plateau basalts were extruded. —*from* Author's abstract

03908 **Szabo, B. J.; Rosholt, J. N.** Uranium-series dating of Pleistocene molluscan shells from southern California—An open system model: Jour. Geophys. Research, v. 74, no. 12, p. 3253-3260, illus., tables, 1969.

Pleistocene molluscan shells from the marine deposits of southern California were dated by the uranium-series disequilibrium method. The closed system ages were calculated from the measured Th-230/U-235 and Pa-231/U-235 activity ratios. Because of discordances found between the Th-230 and Pa-231 ages of many of the shell samples analyzed, it was assumed that shells do not usually form an ideal closed system. A mathematical solution for an open system model that can compensate for the deviation of a sample from the closed system model is proposed. The average open system ages of the first terrace at San Pedro of the Palos Verdes Hills and the Dume terrace and terrace C at Point Dume were calculated to be near 85,000, 105,000, and 130,000 years, respectively.—Authors' abstract

03997 **Szabo, Ernest.** Pennsylvanian paleotectonics of the Paradox region in parts of Utah, Arizona, New Mexico, and Colorado [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4717B, 1969.

Takahashi, K. *See* Fukunaga, O. 03688

03946 **Tamers, M. A.** Instituto Venezolano de Investigaciones Cientificas natural radiocarbon measurements IV: Radiocarbon, v. 11, no. 2, p. 396-422, illus., 1969.

The laboratory renewed operations in January 1968 after a year's inactivity. Groundwater samples are from Venezuela; archeologic samples are from Venezuela, Jamaica, Chile, Curaçao, Dominican Republic, Argentina, Mexico, United States; and ethnological, known-age, and geologic samples are from Venezuela.—MCM

04047 **Tanner, William F.** The particle size scale: Jour. Sed. Petrology, v. 39, no. 2, p. 809-812, 1969.

The S.E.P.M. Grain Size Study Committee has produced several reports, of which this is the third. The phi-scale has the following specific advantages: (1) evenly-spaced division points, facilitating plotting, (2) geometric basis, allowing equally close inspection of all parts of the size spectrum, (3) simplicity of subdivisions of classes into any precision desired, with no awkward numbers, (4) wide range of sizes, extending automatically to any extreme, (5) widespread acceptance, (6) coincidence of major dividing points with natural class boundaries (approximately), (7) ease of use in probability analysis, (8) ease of use in computing statistical parameters, (9) amenability to more-advanced analytical methods, (10) fairly close approximation to most other scales, allowing easy adoption, (11) phi-size screens are already available commercially. —*from* Author's abstract

Tappan, Helen. *See* Loeblich, Alfred R., Jr. 03660

03962 **Taylor, F. C.** Reconnaissance geology of a part of the Precambrian shield, northeastern Quebec and northern Labrador 14 L (N 1/2), 14 M, 23 P (W 1/2), 24 B, G, J, I, P, 25A: Canada Geol. Survey Paper 68-43, 13 p., illus., geol. map, 1969.

Although the Torngat Mountains, in the northeast part of the area, rise to 5,000 feet, much of the region comprises plains and plateaus that are seldom more than 3,000 feet above sea level. All exposed bedrock is Precambrian and all is Proterozoic in age with the exception of a narrow zone of Archean gneiss that extends from Saglek to Trout Trap Fiord on the Labrador coast. Proterozoic rocks form three main divisions: rocks of the Labrador Trough; a large area of gneisses north of the Labrador Trough; the Ramah Group. No mineral occurrences of economic importance were discovered but the area has not been thoroughly prospected. Areas underlain by Labrador Trough rocks, rusty graphitic gneisses, and the Ramah Group offer the best prospecting opportunities.—Author's abstract

tenKate, W. G. *See* Ehrlinger, H. P., 3d. 03949

Tera, F. *See* Eugster, O. 04058

Terlecky, P. Michael. *See* Pilkey, Orrin H. 04062

03786 **Texas Univ. Bur. Econ. Geology.** Geologic atlas of Texas, Amarillo sheet (Leroy Thompson Patton Memorial Edition): Austin, Tex., Univ. Texas Bur. Econ. Geology, scale 1:250,000, 1969

04192 **Thaden, Robert E.; Lewis, Richard Q., Sr.** Geologic map of the Faubush quadrangle, Pulaski and Russell Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-802, scale 1:24,000, section, text, 1969.

Limestone suitable for a variety of uses is available in the Faubush quadrangle from the Salem and Warsaw Formations, Ste. Genevieve Limestone Member, and Monteagle and St. Louis Limestones. Gravel from alluvial deposits in larger valley bottoms is used mostly for road metal on secondary roads and farm lanes. —MCM

04045 **Theron, J. C.** Centrifuge separation of heavy minerals—A new apparatus: Jour. Sed. Petrology, v. 39, no. 2, p. 815-819, illus., table, 1969.

A new instrument to aid the separation of heavy minerals is described. The apparatus delivers a larger crop than with conventional funnel method for fine-grained fractions, and the standard error is also smaller. The instrument and method is described in detail and a short summary of the results obtained is given. It is suggested that the instrument be applied for describing the heavy-mineral content of sand samples quantitatively. The experimental error introduced during the filtering off, drying, and weighing of samples was also tested, and appears to be the main source of the experimental error. The optimum size sample size for the instrument was determined. —Author's abstract

03687 **Thomas, Alwyne.** Oil in Arctic Alaska: New Scientist, v. 41, no. 641, p. 620-622, illus., table, 1969.

The history and geological background of petroleum exploration on the Arctic Slope of Alaska is reviewed briefly; a sketch map locates known oil and gas seepages, most of them concentrated on two major structures of the Arctic Ocean coast. A simplified tabulation of geological succession indicates petroleum significance of various formations. The first test-well in the Colville structure (1965-66) proved commercially unsuccessful; the Prudhoe Bay structure was tested in 1967-68, with discovery of what appears to be one of the world's largest oilfields. At a site only three miles from this test, British Petroleum drillers have struck oil at a depth of 8,000 feet in the Triassic Ivishak formation, where reserves might be between five and ten billion bbls.—GDC

Thomas, Chester E., Jr. *See* Thomas, Mendall P. 03658

03658 **Thomas, Mendall P.; Ryder, Robert B.; Thomas, Chester E., Jr.** Hydrogeologic data for the southwestern coastal river basins, Connecticut: Connecticut Water Resources Bull. 18, 45 p., illus., tables, 1969.

Hydrologic and geologic data presented here document and supplement a companion interpretive report evaluating water resources of the southwestern coastal river basins, to be published as Bulletin 17 in this series. Data were collected during the period July 1963-November 1966. Tabulated data include records of selected wells, laboratory analyses of samples of stratified drift, records of pumping tests of wells, water-level measurements, streamflow records, chemical analyses of water from wells, streams, lakes, and reservoirs. A map shows locations of data-collection sites.—MCM

Thomas, N. O. *See* Krieger, R. A. 03691

04048 **Thomas, R. L.** A note on the relationship of grain size, clay content, quartz and organic carbon in some Lake Erie and Lake Ontario sediments: Jour. Sed. Petrology, v. 39, no. 2, p. 803-809, illus., tables, 1969.

An examination of the geochemistry of fine-grained sediments in relation to size frequency distribution was carried out on sediment samples from Lakes Erie and Ontario. This study demonstrated a direct relationship between the <2 micron grain size and the theoretical clay content computed from the organic carbon, quartz, and carbonate content. A sympathetic relationship was observed between clay content and organic carbon, and also between median grain size and quartz content. The former relationship is believed to be the result of absorption from solution, and the latter is brought about by natural sedimentation from suspension. —Author's abstract

Thompson, G. *See* Phillips, J. D. 03919

03965 **Thompson, J. B., Jr.; Waldbaum, D. R.** Analysis of the two-phase region halite-sylvite in the system NaCl-KCl: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 671-690, illus., tables, 1969.

The crystalline solutions in the system NaCl-KCl provide a useful model for comparison with more complex Na-K solutions such as the alkali feldspars and micas. Analytic expressions for the solvus bounding a binary two-phase region may be obtained by the following methods using pairs of coexisting phases: (1) plotting appropriate functions of composition against reciprocal temperature and obtaining Margules parameters by linear least squares fits to the values plotted; (2) making use of near-linear relationships in the critical region between the square of the composition difference between two phases, the mean composition, and either temperature or reciprocal temperature. The two methods are in good quantitative agreement in the range 300-500°C. —*from* Authors' abstract

03998 **Tikrity, Sammi Sherif.** Tectonic genesis of the Ozark Uplift [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4717B, 1969.

Timko, Donald J. *See* Overton, Harold L. 03911

Tipper, H. W. *See* Frebold, Hans. 03663

Tipper, H. W. *See* Frebold, Hans. 03893

03827 **Tobisch, Othmar T.; Glover, Lynn, 3d.** Metamorphic changes across part of the Carolina slate belt-Charlotte belt boundary, North Carolina and Virginia, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C1-C7, illus., tables, 1969.

Each of the five distinct metamorphic zones developed along the boundary between the Carolina slate belt and Charlotte belt is defined by index minerals and characteristic mineral assemblages in rocks of at least three different bulk chemical compositions. The metamorphic zones form a progressive sequence across the boundary and are correlated with regional metamorphic facies ranging from greenschist to upper amphibolite. Investigation of anorthite content of plagioclase by X-ray diffraction has shown that plagioclase in the lower grade zones is probably a peristerite, which is absent from higher grade zones where plagioclase is more calcic than An_{20}. On the basis of field and laboratory evidence, it is concluded that a metamorphic gradient is one of several factors that define the boundary between the two geological belts in this part of the southern Appalachians.—*from* Authors' abstract

03832 **Toksöz, M. Nafi; Arkani-Hamed, Jafar; Knight, Curtis A.** Geophysical data and long-wave heterogeneities of the Earth's mantle: Jour. Geophys. Research, v. 74, no. 15, p. 3751-3770, illus., tables, 1969.

To investigate the presence and nature of lateral heterogeneities in the mantle, geophysical data with global distribution are analyzed and correlated. From interpretation of results, jointly with available laboratory data on velocity-density relations and the temperature coefficient of velocity, it is concluded: (1) Lateral mass anomalies and/or density variations in the mantle are larger by at least an order of magnitude from that required to explain satellite data; surface topography and crustal structure introduce loads which are compensated in the upper, and perhaps

lower, mantle giving rise to lateral density anomalies in the mantle. (2) Surface heat-flow variations are controlled primarily by shallow structure and tectonic features. (3) At long wavelengths, gravitational, heat flow, and traveltime variations are not correlated with topographic elevations.—*from* Authors' abstract

03976 **Torrance, James Kenneth.** Hydraulic conductivity and pressure as limitations to the rate of frost heaving [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4476B, 1969.

04212 **Towell, David G.; Spirn, Regina V.; Winchester, John W.** Europium anomalies and the genesis of basalt—A discussion [of paper by J. A. Philpotts and C. C. Schnetzler, 1968]: Chem. Geology, v. 4, nos. 3-4, p. 461-464, 1969.

The argument advanced by Philpotts and Schnetzler [ibid., v. 3, p. 5-13, 1968] that europium anomalies in igneous rocks and minerals are mainly caused by crystal chemistry without control by oxidation-reduction reactions is refuted on the grounds that the two effects cannot reasonably be separated in a crystallizing igneous melt. —Authors' summary

Tracey, J. I., Jr. *See* McKelvey, V. E. 03725

04059 **Trivedi, B. M. P.; Goel, P. S.** Production of Na-22 and H-3 in a thick silicate target and its application to meteorites: Jour. Geophys. Research, v. 74, no. 15, p. 3909-3917, illus., tables, 1969.

A number of glass plates chosen from a stack of thick targets having the gross chemical composition of stone meteorites, and exposed to 3 Gev protons, were analyzed for Na-22 and H-3. Complete distributions of these nuclides in the thick target assembly were mapped. Cross sections for H-3 and Na-22 production, calculated on the oxygen and silicon target basis, respectively, show significant buildup factors along the depth followed by an exponential decrease. The distribution of H-3, in both radical as well as lateral directions, is comparatively steeper; results are compared with similar published studies on Fe targets. The calculated H-3 and Na-22 production rates in spherical chondrites exposed to cosmic radiation are comparable to the observed range of concentrations of these nuclides in stone meteorites. —*from* Authors' abstract

Troxel, B. W. *See* Cloud, P. E., Jr. 03684

Truesdell, A. H. *See* Jones, Blair F. 03818

03865 **Truesdell, Alfred H.; Jones, Blair F.** Ion association in natural brines, *in* Geochemistry of subsurface brines: Chem. Geology, v. 4, nos. 1-2, p. 51-62, illus., tables, 1969.

Ion complexes in brines may be ion pairs in which the cation remains fully hydrated and the bond between the ions is essentially electrostatic, or coordination complexes in which one or more of the hydration water molecules are replaced by covalent bonds to the anion. Except for Cl^-, the major simple ions in natural brines form ion pairs; trace and minor metals in brines form mainly coordinate complexes. Trace metal contents of closed-basin brines are related to complexes formed with major anions. With a knowledge of the thermodynamic properties of a natural water, many possible reactions with other phases (solids, gases, other liquids) may be predicted. —*from* Authors' summary

Tupper, W. M. *See* Davies, J. L. 03664

04306 **Tupper, W. M.** The geology of the Orvan Brook sulphide deposit, Restigouche County, New Brunswick: Canada Geol. Survey Paper 66-59, 11 p., illus., geol. map, 1969.

The Orvan Brook area lies on the northwest limb of a large northeasterly plunging anticlinorium containing volcanic and sedimentary rocks of the Middle Ordovician

Tetagouche Group. Host rocks in ascending order are quartz and feldspar augen-schists, iron-formation, sericite schist, graphite schist, argillite and greywacke, and meta-andesite. The massive sulfide zone is coextensive with sericite schist or occurs at contact of sericite and overlying graphitic schist; it has a maximum known thickness of 16 feet and has been traced for a length of 8,000 feet and a depth of 500 feet. Sulfides are massive, fine-grained and banded, and consist of pyrite, sphalerite, galena, chalcopyrite, arsenopyrite, and tetrahedrite; approximately 80 percent of the zone is pyrite. —*from* Author's abstract

03999 **Turner, Donald Lloyd.** Potassium argon dates concerning the Tertiary foraminiferal time scale and San Andreas fault displacement [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4718B, 1969.

04319 **Twiss, P. C.; Suess, Erwin; Smith, R. M.** Morphological classification of grass phytoliths: Soil Sci. Soc. America Proc., v. 33, no. 1, p. 109-114, illus., tables, 1969.

Opal phytoliths derived from epidermal cells of grass leaves have been identified in atmospheric dust, soils, paleosols, Pleistocene loess, and deep-sea sediments. By comparing oriented shapes of phytoliths in spodograms of 17 common grass species, four classes and 26 types are proposed which distinguish three groups of subfamilies of Gramineae. The Festucoid class contains eight types of circular, rectangular, elliptical, or oblong forms; the Chloridoid class contains two types of saddle-shaped bodies; the Panicoid class contains 11 types of variations of crosses and dumbbells; the Elongate class contains five types that have no subfamily implications and occur in all 17 species. Because phytoliths of native tall grasses (Pancoid), short grasses (Chloridoid), and common domestic grasses of humid regions (Festucoid) can be distinguished, it is possible to determine whether phytoliths were derived from local or remote sources. —*from* Authors' abstract

04255 **Tyers, John A.** The natural history story of Wind Cave National Park: [Hot Springs, S. Dak.] Wind Cave Natural History Association, 56 p., illus. [1969?].

Wind Cave, in the southern Black Hills of South Dakota, was discovered in 1881, carved by water forces out of the Pahasapa limestone which geologists named after the Sioux Indian word for Black Hills. Inside the cave is a crystal formation of box-work structure, as well as other mineral decorations. The limestone, after several periods of elevation subsidence, became covered by deposits of fine sand, later hardened into the Minnelusa sandstone, buried by several hundred feet of other sedimentary layers, and uplifted into an anticlinal dome. The truncated surface has been eroded by stream action and weathering into hills and valleys, with eventually a thin mantle of soil. The National Park of 44 square miles is a rolling area of grass prairie and wooded slopes with varied plant life and animals. —GDC

04075 **Tyler, John H.** Genesis and environmental energy of a Devonian lagoonal bank near Alpena, Michigan: Jour. Sed. Petrology, v. 39, no. 2, p. 509-520, illus., 1969.

Two units of the type Four Mile Dam Limestone provide petrographic evidence of extreme variations in environmental energy of several tens of feet horizontally. Various facies of biomicrite and biosparite display great variations in the grain/micrite ratio and are thereby interpreted to represent deposition in low-energy lagoon and higher-energy bank environments respectively. Slight variations in elevation of the sedimentary interface were sufficient to determine the degree of winnowing and sorting of the lenticular biosparite unit from the center to the flanks of the crinoidal bank lens. The biosparite phase of deposition was terminated by a phase of locally intense erosional scouring at the center of the lens with contemporaneous deposition at the flanks a short distance away. —Author's abstract

Ulrych, T. J. *See* Stacey, J. S. 03837

03773 **U.S. Geological Survey.** Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C1-C245, illus., tables, 1969.

This paper contains scientific notes and investigations in: (1) geologic studies (petrology and petrography, mineralogy, paleontology and stratigraphy, geomorphology and glacial geology, structural geology, geophysics, rock mechanics, isotope studies, geochemistry, analytical methods, storage and retrieval of geologic data); (2) hydrologic studies (ground water, surface water, floods, hydrologic reconnaissance, hydrologic instrumentation, geochemistry of water); and (3) topographic studies. Pertinent papers are cited separately.—MCM

03950 **U.S. Geological Survey.** Ground-water levels in the United States, 1962-66—North-central states: U.S. Geol. Survey Water-Supply Paper 1976, 117 p., illus., tables, 1969.

Ground-water levels are tabulated for 1962-66 for the states of Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. —MCM

Vacquier, Victor. *See* Warren, Robert E. 03964

VanAndel, S. I. *See* Hospers, J. 04014

VandeLindt, William. *See* Smith, Stewart W. 04111

Vandenburgh, A. S. *See* Jones, Blair F. 03818

03726 **vanDonk, Jan; Mathieu, Guy.** Oxygen isotope compositions of foraminifera and water samples from the Arctic Ocean: Jour. Geophys. Research, v. 74, no. 13, p. 3396-3407, illus., tables, 1969.

The constant δO-18 value of + 1.15 parts per mil with respect to the PDB standard for *Globigerina pachyderma*, since the latter part of the last glacial period, seems to indicate that the δO-18 value and the temperature of the water in which *G. pachyderma* grew have not changed significantly during this time. This implies that the present ice coverage in the Arctic Ocean has remained unchanged during the last 25,000 years. The shift of 1.2 parts per mil in δO-18 for benthonic foraminifera since the end of the last glacial period is consistent with the idea that the deep water mass of the Arctic Ocean is formed outside the Arctic basin.—KAF

04153 **vanEverdingen, R. O.** The Ink Pots—A group of karst springs in the Rocky Mountains near Banff, Alberta: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 545-554, illus., table, 1969.

The Ink Pots are a group of springs in Banff National Park. The one feature that makes these springs of more than passing interest is the greenish milky appearance of two of the ponds in the group. This difference in appearance of the water cannot be explained by dissolved or suspended chemicals, or by algae growth. It can be explained by differences in flow velocity, which cause differential suspension of fine sand and silt. Temperature and chemical character of spring water from the Ink Pots indicate, respectively, shallow circulation and a relatively short 'contact' time. —Author's abstract

04191 **VanHorn, Richard; Griffitts, Wallace R.** Geologic map of the Blacks Ferry quadrangle, Monroe and Cumberland Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-803, scale 1:24,000, section, text, 1969.

Economic mineral resources of the Blacks Ferry quadrangle include petroleum from the Catheys(?) Limestone and in formations between the Catheys(?) and the Knox Dolomite, gravel from stream beds, and limestone from several formations for agricultural use, dimension stone, and road metal. —MCM

VanLoenen, Richard E. *See* Lee, Donald E. 03766

VanSchaack, J. R. *See* Borcherdt, C. A. 04040

04121 **Varma, C. P.** Lower Carboniferous miospores for the Albert Oil Shales (Horton Group) of New Brunswick, Canada: Micropaleontology, v. 15, no. 3, p. 301-324, illus., 1969.

A palynological study of the miospores of the Albert Oil Shales (Tournaisian) of Albert and Westmorland Counties, New Brunswick, Canada, has indicated a fresh water origin of the Albert Formation. The microflora is closely similar to the one recovered from rocks of the Horton Group of Nova Scotia. Thirty-eight determinable spore types have been described, of which seven represent new species. —Author's abstract

03802 **Vaughn, Peter Paul.** Upper Pennsylvanian vertebrates from the Sangre de Cristo Formation of central Colorado: Los Angeles County Mus. Contr. Sci., no. 164, 28 p., illus., 1969.

Recognizable vertebrates include: palaeoniscid fish, two or more kinds of labyrinthodont amphibians, a new genus and species of aistopod amphibian, a new species of the diadectid cotylosaur *Desmatodon*, an ophiacodont pelycosaur referable to *Edaphosaurus* aff. *E. raymondi*. The new aistopod has a mode of costal articulation that seems to be more primitive than that of known Pennsylvanian forms. Materials of the new species of *Desmatodon* greatly expand our knowledge of this hitherto poorly known genus and indicate greater primitiveness than seen in *D. hollandi*. The *Edaphosaurus* shows an approximate time equivalence with the Conemaugh of Pennsylvania. This is the first known occurrence of Pennsylvanian North American tetrapods west of eastern Kansas.—*from* Author's abstract

03803 **Vaughn, Peter Paul.** Early Permian vertebrates from southern New Mexico and their paleozoogeographic significance: Los Angeles County Mus. Contr. Sci., no. 166, 22 p., illus., 1969.

A rhipidistrian fish from the Laborcita and Abo Formations in Otero County is described. In the same band are found a pleurocanth shark, palaeoniscid fishes, an edopid labyrinthodont, and pelycosaurs. *Dimetrodon* comes from the Abo Formation in the Caballo Mountains of Sierra County. This occurrence verifies a prediction that these vertebrates would be found only as members of faunas that lived near borders of persistent seaways. The Wolfcampian vertebrates in northern New Mexico lived under somewhat more upland conditions. The "Midcontinent seaway" could have formed only a partially effective obstacle to distribution of vertebrates. The extensive system of Early Permian positive elements in Colorado and New Mexico formed the backbone of an upland partial obstacle to the distribution at least as effective as the "Midcontinent seaway".—*from* Author's abstract

Vedder, John G. *See* McKelvey, V. E. 03725

04113 **Vere-Jones, D.** A note on the statistical interpretation of Båth's law: Seismol. Soc. America Bull., v. 59, no. 4, p. 1535-1541, illus., 1969.

A theoretical version of Båth's law is derived on the assumption that aftershock magnitudes are independently and exponentially distributed. The results are not fully in agreement with the commonly accepted picture of Båth's law, but it is shown by reference to Utsu's table of Japanese aftershock sequences that the discrepancies may be due to bias introduced by the method of selecting the data for study. —Author's abstract

04000 **Vidale, Rosemary Jacobson.** Calc-silicate bands and metasomatism in a chemical gradient [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 12, pt. 1, p. 4718B-4719B, 1969.

03943 **Vogel, J. C.; Lerman, J. C.** Groningen radiocarbon dates VIII: Radiocarbon, v. 11, no. 2, p. 351-390, 1969.

This list contains dates from Latin America which have been measured mainly during the past few years. Most geologic samples are connected with palynologic studies; in

cases where the influence of man is apparent in the pollen diagrams, this is explicitly mentioned. Geologic samples are from Cuba, Jamaica, Colombia, Guyana, and Argentina; archeologic samples are from Panama, Colombia, Surinam, Peru, and Argentina; and geochemical samples (atmospheric carbon dioxide) are from Argentina.—MCM

03887 **Vokes, Emily H.** The genus *Trajana* (Mollusca, Gastropoda) in the New World: Tulane Studies Geology and Paleontology, v. 7, no. 2, p. 75-83, illus., 1969.

The nassariid genus *Trajana* Gardner, 1948 was diagnosed to include species with closed siphonal canal and circular aperture, surrounded by a raised peristome. Seven species, two new, occurring only in the New World, are at present assigned to the genus, here treated systematically. *T. (Nerva) woodringi*, n.sp., middle Miocene, Panama,is made the type of a new subgenus; with a slit in the siphonal canal and denticulations in a subcircular aperture, it is believed to be ancestral to the *Trajana* s.s. group, of which *T. (Trajana) pyta*, upper Miocene, North Carolina and Florida, is the type species. Other species of the s.s. group are *T. (T.) veracruziana*, n.sp., upper Miocene, Mexico and Florida, two Tertiary species from South America, and two species living off the west coast of Mexico.—VMJ

03785 **Volborth, Alexis.** Elemental analysis in geochemistry—Pt.] A, Major elements: Amsterdam and New York, Elsevier Publishing Co. (Methods in Geochemistry and Geophysics Ser. 8), 373 p., illus., tables, 1969.

The development of fast instrumental techniques has focused attention on the importance of major constituents in geochemistry; this textbook basically a manual of methods that will form the basis for further refinements in analysis, presents a minimum of methods and theoretical background for determinations on a geochemical or complex inorganic sample. Chapter headings are: introduction, preparation and decomposition of samples, statistical evaluation and sampling, factors influencing selection of methods of separation and analysis, some methods of extraction and ion exchange separation, classical qualitative separation scheme, classical gravimetric and other methods, classical volumetric methods, emission flame spectrophotometry, atomic absorption spectroscopy, instrumental nondestructive analysis, X-ray emission analysis, and fast-neutron activation analysis.—MCM

VonHerzen, R. P. *See* Phillips, J. D. 03919

04177 **vonReichenbach, H. Graf.; Rich, C. I.** Potassium release from muscovite as influenced by particle size [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 17, no. 1, p. 23-29, illus., table, 1969.

Completeness of exchange of K from muscovite by Ba^{2+} ions decreased with particle size below 20μ. Accompanying K exchange at 120°C was marked loss of Si and formation of boehmite in finer fractions. Possible explanations for unexpected high K retention of fine mica fractions are discussed. Formation of a diffusion-inhibiting surface 'skin' is discounted, because equilibrium was obtained more rapidly with fine than with coarser fractions. Average degree of bending of unit mica layers due to peripheral expansion is probably greater in large particles. With bending, rotation of tetrahedra and shifting of adjacent layers with respect to each other may induce greater release of K and lower selectivity for this ion. Fault planes may induce preferential expansion of individual layers and initiate interstratification and splitting of particles which may reduce bending and increase K selectivity. —*from* Authors' abstract

04266 **Vos, M. A.** Stone resources of the Niagara Escarpment: Ontario Dept. Mines Indus. Mineral Rept. 31, 68 p., illus., tables, 1969.

This study area, from Niagara Falls to Manitoulin Island, covers ground between the Escarpment and the Welland River, Grand River and Highway 10 to Owen Sound, and also Bruce Peninsula. Current supplies of construction materials for the Toronto-Hamilton area are from a few large operations on the Niagara Escarpment. In 1966 thirteen quarries were producing from the Lockport-Amabel Dolomite which under-

lies the area. Production figures of various raw materials for 1966 and 1950 are compared; respective total values are 82,211,915 and 19,273,985 dollars. Directly underlying the Escarpment are Silurian formations of the Niagaran Series, partially classified here and described with chemical analyses for areas of carefully planned potential development. Maps showing drift thickness, in 5 sheets, are in back pocket. —GDC

03815 **Waddington, Jean C. B.** A stratigraphic record of the pollen influx to a lake in the Big Woods of Minnesota, *in* United States contributions to Quaternary research—Internat. Assoc. Quaternary Research, 8th Cong., Paris, 1969: Geol. Soc. America Spec. Paper 123, p. 263-282, illus., tables, 1969.

Pollen concentration and 8 C-14 dates from a 16-m core, provide an estimate of pollen influx to a small lake in south-central Minnesota. Changes in pollen influx are related to variation in water level and movement of sediment. Pollen stratigraphy indicates the Rutz Lake area was covered by boreal forest at the time the lake was formed and by a parkland of deciduous trees shortly after. Prairie dominated the area from about 8000 to 3200 yr ago, when an increase in moisture favored an oak parkland again. Remaining openings were invaded by the mixed deciduous forest known as the Big Woods about 400 yr ago. The charcoal content of the sediment is maximum during time of greatest prairie expansion and confirms the importance of fire in a prairie environment.—*from* Author's abstract

Waldbaum, D. R. *See* Thompson, J. B., Jr. 03965

04155 **Waldman, M.** On an immature specimen of *Kritosaurus notabilis* (Lambe), (Ornithischia:Hadrosauridae) from the Upper Cretaceous of Alberta, Canada: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 569-576, illus., table, 1969.

A juvenile hadrosaurine dinosaur, *Kritosaurus notabilis* (Lambe), is described from the Oldman Formation, Upper Cretaceous, Alberta. It is evident that the characteristically broad skull-roof of this genus is not developed until the individual is more than half-grown, and that this is probably true for other hadrosaurines. The status of the species of *Kritosaurus* is reviewed, and it is considered that *K. incurvimanus* may be an immature *K. navajovius*. The nomenclature of the anterior part of the neurocranium is discussed briefly, the element formerly described as a presphenoid being now designated as the septosphenoid interorbital septum.—Author's abstract

04043 **Walker, Charles W.** A method for the preparation of halite thin-sections: Jour. Sed. Petrology, v. 39, no. 2, p. 799, 1969.

A suitable method for the preparation of water-soluble halite thin sections is described. It employs a casting plastic which serves as the mounting media. —Author's abstract

03761 **Walker, George W.** Possible fissure vent for a Pliocene ash-flow tuff, Buzzard Creek area, Harney County, Oregon, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C8-C17, illus., table, 1969.

Steeply inclined foliation and lineation, manifested by flattened and stretched pumice fragments, indicate nearly vertical laminar flowage in a restricted area of a large-volume Pliocene ash-flow tuff. The orientation of these structures and their presence in only the basal part of the ash flow in a small area are suggestive of fissure vents related to a northwest-trending graben, although some of the structures could have formed during compaction-welding and flowage away from underlying topographic highs.—Author's abstract

04126 **Walker, James L.; Sherman, G. Donald; Katsura, Takashi.** The iron and titanium minerals in the titaniferous ferruginous latosols of Hawaii: Pacific Sci., v. 23, no. 3, p. 291-304, illus., tables, 1969.

Titaniferous ferruginous latosols, the Naiwa soils on Kauai, have developed by pedogenetic weathering of basic and ultrabasic lavas and ash in a climate of alternat-

ing dry and wet seasons. Under native vegetation, these soils have an undifferentiated profile of very friable silt; when exposed to dehydration, the profile undergoes tremendous change, developing an indurated surfacee horizon with two-fold increase of bulk and particle density. Amorphous hydrated titanium and iron oxides are converted to crystalline anatase, rutile, pseudobrookite, titanohematite, and titanomaghemite. Rapid movement of colloidal material results in accumulation of titaniferous minerals and amorphous silica at the surface; aluminum oxides are removed to lower horizons and may accumulate as pockets of gibbsite nodules. —*from* Authors' abstract

04227 **Walker, L. K.** Secondary settlement in sensitive clays—Discussion [of four papers from 20th Canadian Soil Mechanics Conf., 1967], *in* Canadian Soil Mechanics Conf., 21st, Winnipeg, 1968, Pt. 2: Canadian Geotech. Jour., v. 6, no. 2, p. 219-222, illus., tables, 1969.

Case histories on sensitive clays report appreciable long-term settlements, unpredicted by standard settlement analysis and often a significant proportion of the total observed settlement. In four conference papers of 1967, a reasonable assessment of secondary consolidation can be made for settlement-time data; in two, pore-pressure test data suggest secondary consolidation progressing in presence of excess porewater pressures of up to 3-4 psi. Supported by data from Queen's University laboratory tests on Leda clay, this may be related to the cemented nature of the soil structure. Estimated secondary settlement rates from field and laboratory, plotted in mean curves, show increase in creep rate with decreasing consolidation ratio, highest rates after preconsolidation pressure has been exceeded. To use these for predicting field performance, laboratory pressures must closely reflect stresses applied to soil in situ. —GDC

Walker, R. M. *See* Condie, Kent C. 03701

03894 **Walker, Roger G.** Geometrical analysis of ripple-drift cross-lamination: Canadian Jour. Earth Sci., v. 6, no. 3, p. 383-391, illus., table, 1969.

The climbing ripples have been measured from the Cloridorme Formation turbidites of the northern Gaspé Peninsula. Purely geometric analysis shows that the angle of the stoss side is more sensitive in controlling the angle of climb than the angle of the lee side, but the single most important factor is the ratio of thickness of the stoss side and lee side laminae. When the lee laminae are about twice as thick as the stoss laminae, the angle of climb is about 30-40°. If the ratio is greater than about 10, the angle of climb is reduced about 5° . Laminae thicknesses are controlled by rate of deposition from suspension relative to rate of bed load movement. In the Cloridorme Formation the turbidites are proximal, and hence a rapid flattening of the basin floor gradient is suggested.—*from* Author's abstract

04030 **Walsh, J. B.** New analysis of attenuation in partially melted rock: Jour. Geophys. Research, v. 74, no. 17, p. 4333-4337, 1969.

A model of partially melted rock is analyzed in which melt occurs as thin films along grain boundaries. For analysis, the liquid phase is assumed to be a dispersion of randomly oriented ellipsoidal inclusions with minor axes much smaller than major axes. Expressions are derived for complex bulk modulus and rigidity. Rigidity and attenuation in pure shear are found to depend on the number of sites at which melting has occurred rather than to depend only on the concentration of melt, in agreement with published observations. On the other hand, response in pure dilatation depends on concentration alone, with the result that attenuation in pure dilatation is low and bulk modulus is approximately equal to that for unmelted material. —Author's abstract

04203 **Walters, Kenneth L.; Glancy, P. A.** Reconnaissance of geology and of ground-water occurrence in Whitman County, Washington: Washington Dept. Water Resources Water Supply Bull. 26, 169 p., illus., tables, geol. maps, 1969.

Most of Whitman County is underlain by a thick sequence of basalt flows mantled by loess; locally older nonbasaltic crystalline rocks are exposed, principally in the eastern part. Crystalline rocks normally contain very little water, but where fractured, may contain enough water for domestic needs. Elsewhere, deposits of coarse-grained materials weathered from crystalline rocks may yield several hundred gpm to wells. Basalt of the Columbia River Group is the principal consolidated rock exposed; its maximum thickness is unknown but probably exceeds 5,000 feet. Yield of large-diameter wells is about 125-200 gpm for every 100 feet saturated basalt penetrated. Adequate yields for domestic and stock supplies are obtained from loess or contact between loess and underlying basalt. The quality of ground water is generally acceptable. —*from* Authors' abstract

04156 **Wardlaw, N. C.; Stauffer, M. R.; Hoque, M.** Striations, giant grooves, and superposed drag folds, Interlake area, Manitoba: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 577-593, illus., 1969.

Cross-cutting relationships of glacial striations on carbonate bedrock, in the Steep Rock-Gypsumville district, Manitoba, suggest movement of ice was generally to the southeast followed by movement generally to the west or southwest. These are similar to directions of linear topographic depressions and ridges of low relief, conspicuous on air photos. The surface grooves overlie grooves in bedrock which are from glacial erosion. The surface grooves cannot be correlated in trend to joints in the bedrock. The similarity between two sets of superposed folds, in gypsum and in carbonates, suggests a common origin. The trends of the axial planes of the two sets of folds are approximately perpendicular to the two major trends of glacial striations and grooves. Glacial drag is the most probable cause of folding in the gypsum and the carbonates. —*from* Authors' abstract

04138 **Warnke, D. A.** A geologic investigation of the Halloran Hills, central Mojave Desert, California: Geol. Rundschau, v. 58, no. 3, p. 998-1047, illus., geol. map, 1969.

The Halloran Hills consist of Precambrian(?) metamorphic rocks, Mesozoic intrusives, Tertiary volcanic breccias and sediments, and Quaternary alluvium. The Halloran Precambrian(?) complex is divided into Silver Lake Peak Formation, mainly quartzo-feldspathic gneisses; Cree Camp Formation, quartzites and metarhyolites; and Riggs Formation, metamorphosed carbonate rocks. There are also some dioritic intrusions. During the Mesozoic, perhaps in the Laramide orogeny, the complex was intruded by a mesozonal pluton, the center of which consists of quartz monzonite while the periphery is more mafic. During the Tertiary, autoclastic friction breccias of andesite-basalt composition were introduced, and later (Pliocene) a large part of the surface near Halloran Spring was covered with basaltic lavas. Questions concerning tectonics and magmatism are discussed in relation to the origin of these series. —DBV

Warren, D. H. *See* Iyer, H. M. 04039

03964 **Warren, Robert E.; Sclater, John G.; Vacquier, Victor; Roy, Robert F.** A comparison of terrestrial heat flow and transient geomagnetic fluctuations in the southwestern United States: Geophysics, v. 34, no. 3, p. 463-478, illus., tables, 1969.

Magnetic time-variations between Tucson, Ariz., and Sweetwater, Tex., indicate that a zone of high electrical conductivity underlies the southwestern United States. The interpretation of this zone by Schmucker as a rise of the isotherms in the upper mantle is supported by six heat flow observations along the line of the geomagnetic profile. These and other observations indicate a high but variable heat flow in the Basin and Range Province which contrasts strongly with the uniform values of 1.1μ cal per sq cm sec reported for the Texas Foreland. The width of this high heat flow anomaly suggests anomalously high temperatures in the upper mantle. This interpretation is further supported by magnetotelluric data between Phoenix, Arizona, and Roswell, New Mexico, and by the low seismic P_n velocity and negative gravity anomaly. —*from* Authors' abstract

04005 **Wasserburg, G. J.; Huneke, J. C.; Burnett, D. S.** Correlation between fission tracks and fission type xenon in meteoritic whitlockite: Jour. Geophys. Research, v. 74, no. 17, p. 4221-4232, illus., tables, 1969.

Whitlockite from the St. Severin chondrite, previously shown to contain excess fission tracks, is here shown to have a large concentration of excess neutron-rich xenon isotopes. The concentration of excess heavy Xe in the whitlockite is about 25 times that calculated from track density. An isotopic spectrum is deduced that is identical to the spectrum calculated previously for excess heavy Xe in the Pasamonte achondrite. These results uniquely associate this Xe spectrum with in place fission in meteorites. Chemical arguments support the correlation of this with Pu-244. Identification of the fissioning nucleus as Pu-244 gives Pu-244/U-238 ≈ 1/30. Neither "sudden" nor "uniform" nucleosynthetic models give consistent solutions for Pu-244/U-238 and U-235/U-238.— Authors' abstract

Wasserburg, G. J. *See* Eugster, O. 04058

03700 **Wasson, John T.** Primordial rare gases in the atmosphere of the Earth: Nature, v. 223, no. 5202, p. 163-165, illus., 1969.

The primordial rare gases in stony meteorites consist of a planetary component, with relative abundances similar to those in the Earth's atmosphere, and a solar component, with abundances closely resembling the mean solar system abundances. If the same processes were responsible for the rare gas distribution in the Earth's atmosphere and in the planetary rare gas composition of meteorites, the simplest explanation of the abundance of these gases on Earth is that they were trapped within solid particles and subsequently outgassed into the atmosphere. There is no evidence that any appreciable fraction has resulted from capture of solar gases.—DBV

04276 **Watts, Frederick J.; Simons, Daryl B.; Richardson, Everett V.** Variation of α and β values in a lined open channel—Closure [to discussion of paper 5593, 1967]: Am. Soc. Civil Engineers Proc., v. 95, Jour. Hydraulics Div., no. HY 3, p. 1059, 1969.

Of particular interest in the 1968 discussion of paper 5593 (ibid., v. 93, no. HY 6, p. 217-234, 1967) is the discussion of α values in natural channels by Cobb which clearly indicates significantly large values of α. The paper was limited to the effect of sharp bends on the value of α for lined prismatic channels. —GDC

04249 **Wedepohl, K. H.** (editor). Handbook of geochemistry, V. 2: Berlin and New York, Springer-Verlag, looseleaf, illus., tables, 1969.

Each element, with the exception of noble gases, lanthanides, and platinum elements, will be treated in a separate chapter of this volume, sections to be issued at intervals and interleaved. Chapters have the atomic numbers of the elements and each will contain standard sections by various authors on: crystal chemistry; isotopes in nature; abundance in cosmos, meteorites, and tektites; abundance in rock-forming minerals and minerals; abundance in common igneous rock types; behavior in magmatogenic processes; behavior during weathering and alteration of rocks; solubilities of compounds which control concentrations of the element in natural waters, adsorption processes, valence states in natural environments; abundance in natural waters and in the atmosphere; abundance in common sediments and sedimentary rock types; biogeochemistry; abundance in common metamorphic rock types; behavior in metamorphic reactions; relations to other elements, economic importance, etc. —MCM

03935 **Weertman, J.** Water lubrication mechanism of glacier surges, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 929-939, illus., tables; discussion, p. 939-942, 1969.

The author reviews and amplifies his theory of glacier surges. This theory is based on the premise that a glacier surge occurs when a water layer at the base of a glacier attains a thickness sufficient to drown the obstacles in the bed that offer the greatest hindrance to sliding. The following new result is presented: in the case of a glacier

bed which is very smooth, the stress concentrations in the vicinity of obstacles in the bed are so high that the power-law creep equation is no longer valid. As a consequence, the size of the controlling obstacles is reduced and thus a surge is more likely to occur.—Author's abstract

03828 **Wels, Paul L.** Glacial drainage divide in the Skagit Valley, Washington, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C71-C74, illus., 1969.

Major valleys in the western part of the North Cascades primitive area have been intensely glaciated and characteristically have U-shaped cross sections, steep walls, flat floors, and relatively gentle gradients. A notable exception is the Skagit Valley, which has a segment about 7 miles long with a steep gradient and the V-shaped cross section characteristic of stream erosion. The valley upstream and downstream from the V-shaped gorge has the typical U-shaped cross section of a glaciated valley. This anomalous section of the Skagit Valley may best be explained by the hypothesis that it was a drainage divide during late Pleistocene time and was occupied by relatively stagnant ice.—Author's abstract

03736 **Welborn, Clarence T.** Comparative results of sediment sampling with a surface sampler and depth-integrating samplers, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C184-C187, illus., 1969.

An investigation was made to determine the possibility of correlating sediment data from samples collected with a surface sampler with data from samples collected with depth-integrating samplers. The results of the investigation show that a coefficient can be computed for sediment concentrations collected with a surface sampler from streams that carry small amounts of sand. It was not possible to compute a single coefficient that could be applied to the samples collected with a surface sampler from streams carrying a significant sand load.—Author's abstract

03859 **Wenk, Hans-Rudolf.** Polymorphism of wollastonite: Contr. Mineralogy and Petrology, v. 22, no. 3, p. 238-247, illus., tables, 1969.

Different superstructures of wollastonite from the regional metamorphic areas of the Alps and the Sierra Nevada in California have been found. Besides well ordered crystals, all disordered intermediate states exist. The superstructure is observed in reflections hkl k = odd. 4T-wollastonite is described as $a_o = 31.659$ A and is a common polymorph. The superstructure seems to be independent of metamorphic grade and occurs only in strained rocks with well developed lineation and strong preferred orientation, and thus its formation is a deformation effect. Contrary to T and P, both stress and strain show large local variations and inhomogeneities. Experiments produced complete disorder of 2T-wollastonite at 4 kb and 700°C. Superstructures in chain silicates may be more common than presently known and could be useful petrogenic indicators.—*from* Author's abstract

04013 **Wentz, Dennis A.; Lee, G. Fred.** Sedimentary phosphorus in lake cores—Analytical procedure: Environmental Sci. and Technology, v. 3, no. 8, p. 750-754, illus., tables, 1969.

A dilute Hcl-H_2SO_4 extraction method for removing biologically available phosphorus from lake sediments is presented. Sample size, pH of sediment-extractant mixture, and sample pretreatment, including drying and grinding, all significantly affect the amount of phosphorus removed. In theory, all sorbed orthophosphate should be leached from the sediment at the pH employed (1.1). When added in known amounts to the sediment, fluorapatite and calcium phytate showed 88 and 11 percent recovery, but AMP and $FePO_4$ were not significantly recovered. FeS at a concentration of 22.3 mg of Fe per gram of dry sediment does not interfere. Extracted phosphorus is measured using a modified vanadomolybdophosphoric yellow color (spectrophotometric) procedure. The technique may have applications in study of accelerated eutrophication.—VMJ

04015 **Wentz, Dennis A.; Lee, G. Fred.** Sedimentary phosphorus in lake cores—Observations on depositional pattern in Lake Mendota: Environmental Sci. and Technology, v. 3, no. 8, p. 754-759, illus., table, 1969.

An extraction procedure for available phosphorus, using dilute HCl-H_2SO_4 (Wentz, 1969), was used to analyze a core from the deepest portion of Lake Mendota, Wis. The rate of available-phosphorus deposition was constant in the marl, increased concomitantly with the change from marl to sludge, reached a maximum about 30 cm below the sediment-water interface, and decreased gradually toward the surface. The initial increase probably corresponds to man's first appearance in the watershed; the decrease may be associated with removal of sewage effluent from the lake in 1899. The available phosphorus comprises about half of the total and appears to be associated with the carbonate portion of the sediment. —*from* Authors' abstract

03971 **Wershaw, R. L.; Bohner, G. E., Jr.** Pyrolysis of humic and fulvic acids: Geochim. et Cosmochim. Acta, v. 33, no. 6, p. 757-762, illus., table, 1969.

Pyrolysis of humic and fulvic acids isolated from a North Carolina soil yields a variety of aromatic, heterocyclic and straight chain organ compounds. The pyrolysis products identified by gas chromatography and mass spectrometry indicate that humic and fulvic acids have aromatic and polysaccharide structures in their molecules. —Authors' abstract

Westphal, W. H. *See* Lange, A. L. 04026

04023 **Wetherill, G. W.** Comments [on paper by D. E. Fisher and M. F. Swanson, "Frequency distribution of meteorite-Earth collisions" (1968)]: Jour. Geophys. Research, v. 74, no. 17, p. 4402-4405, table, 1969.

Though the conclusion of Fisher and Swanson (ibid., v. 73, no. 20, p. 6503-6513, 1968) that the 2:1 afternoon-morning anisotropy in meteorite fall rate is strongly biased by social effects may be valid, their principal argument in support of it is unsound. Unless more compelling arguments are brought forward in its favor, it is unwise to ignore this potential source of information about meteorite orbits. —DBV

Wetherill, G. W. *See* Gopalan, K. 04028

04218 **Whitcomb, James H.** Detection of *SH*-type seismic shear waves by means of angular accelerometers: U.S. Geol. Survey Prof. Paper 599-D, p. D1-D6, illus., 1969.

An unsuccessful attempt to record SH-type seismic shear waves by means of triaxial geophones led to development of a method for recording SH-waves with angular accelerometers. Tests of three types of Statham angular accelerometers are reported. The accelerometers are coupled to the ground at two points in line with direction of wave propagation. In areas where SH-waves are difficult to record, such as in areas of lava flows, clastic rocks, or volcanic ash, angular accelerometers are more effective than triaxial geophones because they discriminate against energy of P, SV, and Rayleigh waves. Angular accelerometer technique could be used on the Moon for determining SH-wave velocity of lunar surface materials. Before the method is applied to lunar studies, however, the relation of SH-wave velocity to physical parameters of transmitting material needs further study. —*from* Author's abstract

04132 **White, George Willard.** Pleistocene deposits of the north-western Allegheny Plateau, U.S.A.: Geol. Soc. London Quart. Jour., v. 124, pt. 2, no. 494, p. 131-151, illus., 1969.

Deposits from two Pleistocene ice lobes overlap Carboniferous strata of the Allegheny Plateau in Ohio and Pennsylvania, where complete sections in recent extensive excavations reveal separate till sheets which, traced for over 100 miles, can be treated as rock stratigraphic units. The younger have more clay, carbonate content, and feldspar in sand than the older; toward the margin in each sheet, feldspar decreases and quartz increases. Areal variation, in computered trend-surface analysis, is ascribed to locally derived sandy debris. Pre-Illinoian till, thoroughly

weathered, is entirely subsurface; the upper of two overlying Illinoian(?) sheets has a thick paleosol. The bulk of the drift, less weathered, in 3 or more early Wisconsinan sheets, is Titusville Till. Successive late Wisconsinan sheets, distinguished by color, texture and composition, are Kent, Lavery, and Hiram Tills, and correlatives. —GDC

04173 **Whitehead, Donald R.; Davis, J. Terrance.** Pollen analysis of an organic clay from the interglacial Flanner Beach Formation, Craven County, North Carolina: Southeastern Geology, v. 10, no. 3, p. 149-164, illus., tables, 1969.

An exposure of interglacial sediments at Flanner Beach, Craven County, North Carolina contains peaty clay with cypress stumps rooted on its surface. A brackish water facies of the Flanner Beach Formation overlies the clay disconformably. Pollen analysis of the organic clay indicates deposition in a fresh water environment. The pollen spectra suggest existence of vegetation quite similar to the present. An interglacial correlation is thus supported. There is some indication of a slight lowering of sea level and/or deterioration of climate towards the end of the depositional interval. The pollen spectra are similar to those described previously from the interglacial Horry Clay from Myrtle Beach, S.C. This corroborates stratigraphic and paleontologic studies which have indicated the similarity of the two sections. It thus seems that the two organic clays date from the same interglacial, presumably the Sangamon. —Authors' abstract

Whitham, K. *See* Hasegawa, H. S. 03841

03690 **Whitmer, Martin T.** Versatile wollastonite: Indus. Minerals, no. 19, p. 16-20, illus., 1969.

This white pyroxene, mined and processed at Willsboro, N. Y., under the name of *Cab-O-Lite*, crystallized in metamorphosed siliceous limestones in which associated garnet, green diopside and calcite are distributed in particles of 1 mm size; their coarseness makes magnetic separation relatively easy. At 1150°C the wollastonite changes to a higher temperature form with a melting point of 1540°. In crushing, the commonly tabular crystals have cleavage which forms blades and needles of short fibre, the basis for many of its uses. The wollastonite is found in numerous separate outcrops in a skarn belt of Precambrian Grenville gneisses, trending N. 70° W. for about six miles, which has been injected and partially replaced by anorthositic magma. Calcite, coating joint surfaces, indicates that the wollastonite formed in two stages of crystallization.—GDC

04084 **Whitmore, D. R. E.** Geology of the Coronation copper deposit, *in* Symposium on the geology of Coronation mine, Saskatchewan: Canada Geol. Survey Paper 68-5, p. 37-53, illus., tables, 1969.

The Coronation mine is developed on a pyritic copper deposit in Precambrian basic volcanic rocks. In comparison with other similar deposits, the Coronation has suffered greater metamorphism and deformation. Three quarters of the deposit consists of an intergrowth of chalcopyrite, pyrite, and pyrrhotite with a cordierite-anthophyllite rock considered to be a metamorphosed chloritic wall rock alteration equivalent to that still characteristic of the footwall of the Flin Flon deposit. About 15 percent consists of massive sulfide veins which in part extend as dike-like apophyses into altered volcanic rocks; 10 percent consists of sulfides redistributed postmetamorphically along late chloritic shear zones and in partly open cavities in some of which stalactitic structures have developed and in others arsenic has been added to the mineralization. —*from* Author's abstract

04232 **Wiedemann, Hartmut U.** Solutions in intertidal and supratidal environments of modern carbonate sedimentation—Their implication on diagenesis: Chem. Geology, v. 4, nos. 3-4, p. 393-409, illus., tables, 1969.

Because of the low solubility of Ca salts as compared with the higher solubility of halite and magnesian salts, a chemical separation of calcium and magnesium takes place during the evaporation of sea water as well as upon dissolution of sea salt in rain water. The counterpart of these Mg-rich solutions is rich in Ca, exhibits pH

values below 9 (around pH 8), and tends to decompose unstable magnesium-calcite and to precipitate $CaCO_3$ and gypsum during evaporation. The tendency for gypsum to precipitate early in the evaporation, and to redissolve readily, makes gypsum a convenient short-term depot for Ca ions in intertidal and supratidal environments where gypsum has to be considered as an ubiquitous reaction partner. —*from* Author's abstract

03902 **Wiggins, Ralph A.** Monte Carlo inversion of body-wave observations: Jour. Geophys. Research, v. 74, no. 12, p. 3171-3181, illus., table, 1969.

An efficient Monte Carlo scheme has been implemented to generate families of velocity models, all of which are consistent with observations of $dT/d\Delta$ versus Δ and T versus Δ. Uncertainties in observations are translated into uncertainties in velocity structure when the envelope of the family of models passed is examined. As an example of application, a set of $dT/d\Delta$ observations of P-wave arrivals measured at Tonto Forest Seismological Observatory in Arizona has been inverted. These observations require that resulting compressional velocity models exhibit two major discontinuities; the uncertainty of depth to these discontinuities is 30-40 km. Contrary to other interpretations, models have been found either with or without a low-velocity layer below the M-discontinuity. Some models contained low-velocity zones immediately above the two major discontinuities.—*from* Author's abstract

04309 **Wilcox, W. R.** Validity of the stagnant film approximation for mass transfer in crystal growth and dissolution: Materials Research Bull., v. 4, no. 4, p. 265-274, illus., 1969.

Crystal growth and dissolution generate a flow of material through the crystal surface. In treating mass transfer by the stagnant film approximation, it is generally assumed that the film thickness is independent of the interfacial flow. The validity of this assumption is examined in detail here. The film thickness is found to be relatively constant for laminar free convection and for a rotating disk in a gas. However it varies significantly for laminar forced convection of a gas over a flat plate. Mass transfer calculations are outlined which take into account the effect of interfacial flow on the film thickness. The results are also applicable to reverse osmosis. —Author's abstract

04027 **Williams, David W.; Kennedy, George C.** Melting curve of diopside to 50 kilobars: Jour. Geophys. Research, v. 74, no. 17, p. 4359-4366, illus., tables, 1969.

A method is described for the determination of silicate melting points to 2000°C and 50 kb, using tungsten-rhenium thermocouples in piston-cylinder apparatus. Pressures are corrected for frictional losses and temperatures for the effect of pressure on the emf of the thermocouple. The melting curve of diopside has been measured to 50 kb; agreement with Boyd and England's 1963 data is good to 30 kb, but present results lie at substantially higher temperatures than theirs at the highest pressure. The difference in the two curves amounts to 88°C at 50 kb. Finally, the melting relationship proposed by Kennedy (1967) is examined for these new data. —Authors' abstract

Williams, F. E. *See* Steven, T. A. 03724

Williams, James H. *See* Lutzen, Edwin E. 03747

04072 **Williams, Peter F.; Rust, Brian R.** The sedimentology of a braided river: Jour. Sed. Petrology, v. 39, no. 2, p. 649-679, illus., table, 1969.

A four-mile tract of the Donjek River, Yukon, Canada, is braided throughout, discharging about 50,000 cfs in the flood. The active part shows upper regime flow, and lacks vegetation. Higher, older levels have continuous flow in the main channels. The lower channels are strongly dissected and the upper (older channels) are being infilled. The sediments vary from clays to coarse gravels; most are poorly sorted. CM plots permit recognition of three groups, and seven facies are recognized on textural, floral, and sedimentary structural characteristics. Facies relations are mostly gradational within channels, commonly fining upwards. They are more complex between

channels and invariably erosional. Six hundred and sixty measurements of small-scale structures show moderate within-bar and directional arcs, and give a grand vector mean 22° from the river trend. —*from* Authors' abstract

03933 **Wilson, A. T.** The climatic effects of large-scale surges of ice sheets, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 911-915; discussion, p. 915-918, 1969.

If a continental ice sheet surged into the sea it would have a considerable effect on world sea-level; this is proposed as the mechanism of past sea-level fluctuations of the Carboniferous and Tertiary. It is concluded that a periodic surge of the Antarctic ice sheet, perhaps induced by a decrease in insolation to the south polar region, has all the requirements of an ice-age mechanism. It is proposed that when the ice sheet surges, a large ice shelf is produced which increases the albedo of the Earth; resulting cooling leads to formation of secondary ice sheets in the Northern Hemisphere, which in turn leads to a further increase in albedo and further cooling. Breakup of the ice shelf and its replacement by ocean would lead to a large decrease in the Earth's albedo; resulting warming would lead to rapid melting of subsidiary ice sheets and ending of the ice age.—*from* Author's abstract

04326 **Wilson, John M.; Criner, James H.** Geohydrology of Henry and Weakley Counties, Tennessee: Nashville, Tenn., Tennessee Div. Water Resources, 49 p., illus., tables, 1969.

Although the geologic character of shallow aquifers in Henry and Weakley Counties differs locally, their hydrologic properties are reasonably uniform in that sufficient quantities of water for domestic and farm use are available; one aquifer can supply municipal and industrial needs in much of the area. Use of ground water in 1967 was estimated at 5 mgpd; rate of withdrawal could be increased several hundred percent without ill effects. Dissolved iron content of shallow supplies is commonly troublesome, but in general chemical quality is excellent for most uses without treatment. Well yields in excess of 1,000 gpm can be obtained from deeper artesian aquifers in all of Weakley County and the western half of Henry County. Bacterial contamination seems due to unsafe well completion practices rather than a polluted resource. —*from* Authors' conclusions

Wilson, T. R. S. *See* Mangelsdorf, P. C., Jr. 03704

Wilson, William H. *See* Bullock, James M. 03670

Winchester, John W. *See* Towell, David G. 04212

04296 **Withrow, Phil C.** Basis for Red Fork Sandstone exploration in northwest Oklahoma [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 97-98, 1968 [1969].

Witterholt, E. J. *See* Lebourg, M. 04301

04193 **Wolcott, Don E.** Geologic map of the Little Hickman quadrangle, central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-792, scale 1:24,000, sections, text, 1969.

Mineral resources of the Little Hickman quadrangle are: (1) sand from alluvium of the Kentucky River and from the river bed, (2) limestone in limited amounts from the Tyrone and upper part of the Oregon Limestones; and (3) barite which was prospected in the early 1900's. The area contains a considerable number of springs. —MCM

04292 **Woncik, John.** Muddy Sandstone development in the Recluse Field, Campbell County, Wyoming [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 94, 1968 [1969].

Wood, Albert E. *See* Harris, John M. 04337

03957 **Wood, G. V.; Blow, W. H.** An introduction to JOIDES: Geol. Soc. London Proc., no. 1651, p. 213-214, discussion, 1969.

The Joint Oceanographic Institute Deep-Earth Sampling program, founded and organized in the U.S.A., involves four legs in the Atlantic and five legs in the Pacific Ocean for drilling in subsea depths as great as 5500 and 6000 m, at sites chosen so as to provide evidence for sea-floor spreading, continuity of sedimentation, and age of the ocean basins. It is hoped to recover evidence bearing on the nature of oceanic rises, heat-flow and consolidation phenomena in deep-water environments as well as primary biostratigraphy. Proposed preliminary core descriptions, to be issued soon after completion of a cruise leg, will be of two types of measurement: on unopened core, such as natural radioactivity, electrical and paleomagnetic data, and on opened core, including sediment composition, grain size and structure, and biostratigraphical data. Petrological and X-ray diffraction studies will follow later.—GDC

04320 **Woolson, E. A.; Axley, J. H.** Clay separation and identification by a density gradient procedure: Soil Sci. Soc. America Proc., v. 33, no. 1, p. 46-48, tables, 1969.

A method was developed for the separation and partial identification of clays using a heavy liquid density gradient column. The columns consisted of five different layers, theoretically permitting seven different separations in one determination. To aid in separation, the original density of the clay was altered by saturation with H, Ca, K, or Cs. The resulting densities were related to changes in the clay interlayer distance as well as to the equivalent weight of the sorbed cations. This density gradient method is simple, quick, and requires only basic laboratory equipment. The density values aid clay mineral identification and in some instances may be the only information needed. —Authors' abstract

04021 **Workman, L. E.; Metherell, R. G.** Geology, Crossfield East and Lone Pine Creek gas fields, Alberta: Bull Canadian Petroleum Geology, v. 17, no. 1, p. 92-108, illus., 1969.

The Crossfield East and Lone Pine gas fields obtain their gas from the Crossfield Member in the middle of the Stettler Formation of Upper Devonian age. Gas comes from porous dolomitized stromatoporoidal and algal bank rock and associated strata which lie west of the west edge of an evaporite basin. Pores consist of vugs of algal origin, original stromatoporoidal organic porosity, and vugs and pin-points produced by groundwater solution. Anhydrite and some calcite cement have greatly reduced initial porosity.—Authors' abstract

Wright, L. A. *See* Cloud, P. E., Jr. 03684

04172 **Yancey, Thomas E.** A molluscan faunal assemblage from the Arcturus Formation, Nevada: PaleoBios, no. 8, 20 p., illus., 1969.

Middle Permian marine rocks of the Arcturus in White Pine County, contain an unusually diverse fauna. Most of the nonreef marine faunal communities in the Pennsylvanian-Permian of the United States are represented. The upper part of the Arcturus Formation contains a dominantly molluscan fauna in shales and interbedded evaporites and limestones. Systematic descriptions of this fauna are given. —ESL

04297 **Yarborough, Hunter.** Geologic history of the Gulf Basin [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 98-99, 1968 [1969].

04254 **Yeck, Ronald D.; Gray, Fenton.** Preliminary studies of opaline phytoliths from selected Oklahoma soils: Oklahoma Acad. Sci. Proc. 1967, v. 38, p. 112-116, illus., 1969.

Percentages of plant opal were determined from leaves and roots of four grasses and two oak species and from the A horizons of three soils in Payne County, Okla.: Zaneis loam, with tall-grass prairie vegetation; Kirkland loam, short-grass prairie; Dougherty soil, oak forest. Opaline residues from both leaves and roots of the grasses were considerably higher than from the trees. Both prairie soils were high in opaline, as expected; the forest soil, unexpectedly, was nearly as high—possibly indicating former prairie vegetation. Opaline was much more abundant in the 5-20μ than in the 20-50μ fraction of the Oklahoma soils; in studies in other states, opaline content of

the fractions was about equal. Opaline phytoliths can serve as a permanent record of the past vegetation and associated climate, although only broad interpretations can be made so far. — VMJ

03731 **Yochelson, Ellis L.** Gastropods, Chap. D *in* Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma: U.S. Geol. Survey Prof. Paper 606-A-F, p. 25-33, illus., 1969.

Seven species of gastropods are included in Girty's work on the Fayetteville Shale fauna; one of the types is actually from Batesville Sandstone. Type specimens are designated, collecting localities are clarified, and original specimens are illustrated. The current placement of his species is: *Oxydiscus venatus* to *Sinuitina*, *Patellostium laevigatum* to *Patellilabia*, *Anomphalus*, *discus* to *Trepospira* (*Angyomphalus*,), *Bembexia lativittata* to *Mourlonia*, and *Orthonychia compressa* to *Platyceras* (*Orthonychia*). *Platyceras subelegans* is included in the typical subgenus and *Euconospira disjuncta* is not reassigned.—*from* Author's abstract

Yokoyama, Takeo. *See* Suzuki, Toru. 03886

04181 **Yole, R. W.** Upper Paleozoic stratigraphy of Vancouver Island, British Columbia [with French abs.]: Geol. Assoc. Canada Proc., v. 20, p. 30-40, illus., tables, geol. map, 1969.

The Paleozoic rocks of Vancouver Island which outcrop in two major belts, one in the central part and the other in the southern part of the island, are assigned to the Sicker Group, early Permian and older. The lower Sicker Group, Youbou Formation, consisting of several thousand feet of volcanic and noncalcareous sedimentary rocks, represents a moderately deep gulf formed during tectonic activity. Most of the upper part of the Group is comprised of the Buttle Lake Formation, 100-1,500 feet of limestone overlain locally by a thin layer of clastics. Measured sections of the Buttle Lake Formation from three widespread areas are described. —*from* Author's abstract

Yoshimoto, J. *See* Fukunaga, O. 03688

03904 **Young, Chapman, 3d.** Dislocations in the deformation of olivine: Am. Jour. Sci., v. 267, no. 7, p. 841-852, illus., tables, 1969.

Experimental uniaxial loading of oriented single crystals at temperatures over 1200°C activated dislocations in (001)[100] and (010)[100] slip systems. The direct observation of dislocation helices extending in [100] strongly suggests that pencil glide in [100] may take place at high temperatures. Triaxial deformation of oriented single crystals revealed that the only important slip system operative at confining pressures up to 5 kb and at temperatures from 500° to 800°C is on {110} planes with a Burger's vector in the [001] direction. Data obtained from the deformation of olivine crystals indicate that dislocation densities in {110}[001] slip systems are proportional to the square root of the shear strain and suggest that dislocation velocities may be quantitatively dependent upon the applied shear stress.—*from* Author's abstract

04143 **Young, G. M.** Inorganic origin of corrugated vermiform structures in the Huronian Gordon Lake Formation near Flack Lake, Ontario: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 1, p. 795-799, illus., 1969.

Early Proterozoic rocks of widely separated areas contain corrugated, spindle-shaped structures, which formerly were considered to be of organic origin. New evidence indicates that some of these structures have formed by both upward and downward injection of silt into fissures in a muddy sediment. The fissures are interpreted as shrinkage cracks formed beneath the sediment-water interface and may possibly indicate the presence of saline waters.—Author's abstract

Youngberg, C. T. *See* Chichester, F. W. 04330

03779 **Zachos, Louis G.** A new echinoid from the Ocala limestone: Florida Acad. Sci. Quart. Jour., v. 31, no. 3, p. 161-164, illus., 1968 [1969].

Echinoids, a very important part of the fauna of the late Eocene Ocala Limestone, are useful in differentiating members. *Eupatagus* is one of the more common genera. One specimen (*E. ingens*) examined differs from any described species; it is here recognized as the type specimen of a new species, and is illustrated and described. —ESL

Zahner, Robert. *See* Farrand, William R. 03813

04235 **Zimmermann, Walter.** About Mesozoic pteridophylls: Am. Jour. Botany, v. 56, no. 7, p. 814-819, illus., 1969.

Two types are common, the *Polypodium* and the Dipteridaceae. The *Polypodium*-type, formed by pendulous overtopping, is represented in the Mesozoic by the form-genus *Cladophlebis*, in the Paleozoic by the form-genus *Pecopteris*, and today by *Dryopteris*. Nearly all Paleozoic forms show catadromic structures. Mesozoic genera demonstrate a transitional structure; catadromic structures are still frequent, but equally frequent are combined catadromic/anadromic structures. Solely anadromic pteridophylls are unknown in the Mesozoic. The Dipteridaceae-type is almost exclusively Mesozoic. It is primitive in the dichotomy of the rachis, but advanced in that it is net-veined. Thus, the pteridophylls represent connecting links between Paleozoic and recent leaf-types. This can be understood only on the basis of the telome theory. —*from* Author's abstract

03829 **Zohdy, Adel A. R.; Jackson, Dallas B.** Electrical sounding profile east of the Jordan Narrows, Utah, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C83-C88, illus., 1969.

In 1967 a profile of electrical soundings was made east of Jordan Narrows to explore the possibility of a buried stream channel that may be contributing large amounts of ground water to Jordan Valley. Soundings were made using the Schlumberger electrode array; the technique of making pairs of crossed soundings provided valuable information on electrical lateral pseudoanisotropy, reflecting complexity of bedrock surface. Probable presence of a step fault system was determined from analysis of curves. It was possible to correlate several geoelectric layers across the profile and to evaluate thicknesses, resistivities, and horizontal extent. Although soundings did not confirm presence of a buried stream channel, data illustrated dependency of electrical sounding curves on sounding line azimuth when sounding is over horizontally inhomogeneous media. —*from* Authors' abstract

04150 **Zwicker, David.** *See* Rankin, Douglas S. 04150

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